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Ministry of Environment
in cooperation with
Ministry of Forests

MOE Manual 11

DESCRIBING ECOSYSTEMS IN THE FIELD

Second Edition

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FOREWORD

The Ministries of Environment and Forests have co-operated to produce both the first and second editions of "Describing Ecosystems in the Field." These Ministries are the largest collectors and users of ecological information in British Columbia and recognize the mutual benefit to each from sharing data.

The purpose of this manual is to standardize approaches and definitions for the collection of ecological data in British Columbia. It is important that efforts be made to use only the definitions in this manual.

The definitions and additions in the second edition take precedence over those in the first edition.

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PREFACE TO THE SECOND EDITION

It is gratifying to report the wide use of the First Edition of the manual by various government agencies, consultants, and universities in British Columbia. It has also been adapted by Alberta Energy and Natural Resources for their uses.

The first five chapters of the manual have been revised to reflect changes in the site, soil, vegetation, and mensuration field description forms. These forms have been modified to facilitate direct entry of field-collected data into provincial computer systems. Detailed information on how these forms are to be coded is now included in the manual.

Chapter six (Wildlife Description) has been rewritten and a new wildlife data form produced. Chapter seven has been added for the description of humus forms to reflect increased interest in this component of ecosystems.

PREFACE TO THE FIRST EDITION

Many agencies are conducting projects that require collection of ecological information. These projects often overlap or are conducted at different scales, for different purposes, and at different times. As well, the type and amount of data collected vary according to objectives of a project. Nevertheless, much of the ecological data that are ultimately collected provide basic information, useful for a variety of resource management decisions. Since collection of ecological information is costly and time consuming, it is prudent to retain data that will remain useful and available for decision-making in the future.

The purpose of this manual is to standardize approaches and definitions for ecological data collection. The manual is designed for use with the site, soil, humus form, vegetation, mensuration, and wildlife field description forms shown in each chapter. The manual and field forms will help ensure there is consistency in the collected data, many of which will be stored in computer files. It is important that efforts be made to use only the definitions contained within this manual.

This manual and the field data forms can be used by ecologists, pedologists, biologists, foresters and others involved in ecological data collection.

Copies of this manual, field forms and aerial photo grid can be obtained from MAPS — B.C., Ministry of Crown Lands, Parliament Buildings, Victoria, B.C. V8V 1X5. You may wish to use the letter format on the next page for requesting field forms. Examples of the data forms are given at the beginning of the appropriate chapters.

ORDER FORM

MAPS — B.C.
Ministry of Crown Lands
Parliament Buildings
Victoria, B.C. V8V 1X5

Could you please send me the following field data forms:

	No. of Copies Requested
Site Description Form	________
Soil Description Form	________
Vegetation Description Form	________
Mensuration Form	________
Wildlife Data Form	________
Humus Form Description	________

I also need the following:

	No. of Copies Requested
Plastic Grids (to overlay on aerial photographs)	________
Soil Laboratory Requisition Form	________
Soil Sample Labels	________
Manual Soil Laboratory Form	________

Name ____________________

Address ____________________

____

____

Phone No. ____________________

Date ____________________

ACKNOWLEDGEMENTS

From the outset, the production of this manual has been a cooperative project, involving most of the agencies involved in ecological inventory in British Columbia. Since the First Edition was printed in 1980, many people have contributed useful suggestions which have been incorporated into the Second Edition.

The editorial committee for the Second Edition consisted of T. Vold, D. Meidinger, D. Demarchi, M. Sondheim, H.A. Luttmerding, E. Lea, and E. Dawson. The editorial committee for the First Edition included M. Walmsley, G. Utzig, T. Vold, D. Moon, and J. van Barneveld. The final, detailed edit of the Second Edition was conducted by H.A. Luttmerding.

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T. Vold (1, 2)
M. Walmsley (1, 2, 3)

Other people have reviewed and contributed to various sections of the manual. The editorial committee is particularly indebted to the ecologists, biologists, and pedologists with the Research Branch (B.C. Ministry of Forests), Wildlife Branch, Waste Management Branch and Recreational Fisheries Branch (B.C. Ministry of Environment), and Surveys and Resource Mapping Branch (B.C. Ministry of Crown Lands), and B.C. Soil Survey Unit (Agriculture Canada) for their continual assistance.

The editors also wish to thank those individuals in private consulting firms, the forest industry, universities, and various other government agencies who provided helpful comments.

Much of this manual has been compiled from other sources, in particular, the Land Resource Research Institute's (1983) "Manual for Describing Soils in the Field"; B.C. Ministry of Forests' (1984) "Cruising Manual"; Klinka *et al.* (1981), "Taxonomic Classification of Humus Forms in Ecosystems of British Columbia — First Approximation"; the manuals for the B.C. Soil Information System (Sondheim *et al.*, 1983); and revisions of wildlife data collection procedures (Pendergast *et al.*, 1982).

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CHAPTER 1

INTRODUCTION

Chapter One

INTRODUCTION

WHO SHOULD USE THE ECOSYSTEMS MANUAL AND DATA FORMS

Prior to the preparation of this manual, individuals had to rely on several different references and other sources of information to describe ecosystems in the field. The manual has brought much of this material together in one, comprehensive, accessible and easily used product.

All ecologists, pedologists, biologists, foresters, and others involved in ecological data collection in British Columbia should consider using this manual and the accompanying field data forms. Their use will ensure greater uniformity and consistency in the collection of environmental data by government agencies, industry, universities, and consultants. Use of the manual, with its' standard terminology and definitions, will improve communication between, and within, particular resource disciplines.

There are two features of the manual and field forms that should be highlighted. First, the manual and data forms are *modular*. A field surveyor can use the Site Description Form with either one or all of the other field forms. For example, if a soil survey is being conducted without regard to other landscape features, such as vegetation or wildlife, then only the Site and Soil Description Forms need be used in the field. Similarily, a wildlife biologist, interested in assessing habitat characteristics, may not need the form dealing with forest mensuration.

Second, the manual and data forms are *flexible*. Not all the defined parameters need to be coded, since they may not be relevant to the project or survey objectives. The project leader decides which parameters must be coded and which can be omitted. For example, a botanist surveying only vegetation may not wish to fill in those parameters on the Site Description Form that deal with soil or geology. In addition, soil surveyors may wish to limit the number of soil parameters they record for short observations, but still complete most of the form for detailed profile descriptions. Project leaders in mapping projects must balance the requirement for an ample number of ground checks with the requirement for useful descriptions.

When deciding on which parameters are to be completed on the data forms, project leaders should keep in mind that the extra time spent on a particular site is often minimal compared with access costs in time and money. Also, ecological or pedological surveys often have potential uses beyond the scope of the immediate project objectives. Thus, it is important to consider others who might benefit if a little more information is obtained.

In this regard, the manual and accompanying data forms may, at first glance, appear overwhelming. However, once an individual is familiar with applying the definitions in the manual and filling in the data forms, experience has shown that it does not take long to observe and record most of the parameters. For example, a surveyor familiar with the manual and data forms can record most parameters on the Site Description Form while a soil pit is being dug.

Project leaders may wish to add to this manual by appending additional data forms as required for a particular survey. For example, agriculturists may add a section for recording agricultural crop production data. Similarly, resource specialists doing research or engaged in special studies (e.g., slope stability, urban suitability, or silvicultural practices) may use portions of the manual and data forms, and add sections relevant to their needs.

The value of this manual and data forms will increase with their use by a broad array of resource disciplines. The use of standard terms to describe the province's resources can only foster improved communications between resource disciplines.

HOW TO USE THE MANUAL

At the beginning of a project, the manual should be continually consulted in the field to ensure that the descriptions of the landscape features are consistent with the definitions provided. Once these definitions are understood and remembered, the surveyors can fill in the data forms by developing project-specific coding sheets. The manual should still be accessible to the field surveyor, as it is easy to forget how some terms are defined.

Although this manual has consolidated information from a number of sources, some additional field material may still be necessary for a particular project. For example, to determine soil horizon designations, reference to the Canadian System of Soil Classification (Expert Committee on Soil Survey, 1987) may still be required. Also, for mensuration data collection, it is necessary to use additional material (e.g., site curves) from the Ministry of Forests' Inventory Manual and Field Pocket Handbook.

SURVEY PLANNING

Surveys vary in their objectives and scope; for example, mapping versus non-mapping (descriptive) surveys, soil versus wildlife surveys, and detailed versus reconnaissance surveys. Consequently it is difficult to suggest planning procedures that are applicable to all types of ecological surveys. Nevertheless, some common elements of survey planning are discussed here.

Preliminary Planning

The objectives and intended uses of the survey will determine the information required at each sample site, the intensity of sampling, and the environmental factors to be described. Most surveys will require information to be collected from a full range of aspects, elevations, slope positions, and landforms.

A list of the essential ecological parameters needed to meet the objectives of the survey should be prepared, such as seral communities for wildlife interpretation and stand types for forest productivity. These parameters will provide a framework for the initial stratification of the sampling area and assist in deciding which additional ecological data are to be collected.

All available and relevant environmental information for the project area should be collected as background material. This normally includes the following:

- topographic maps for elevations, aspects, slope, and access
- aerial photographs
- climatic data
- bedrock geology maps and reports
- surficial geology (terrain) or landform maps and reports
- soil maps and reports
- vegetation information (e.g., on species distribution, zonation, forest cover types, stand ages, logging and fire history)
- present land use information
- land capabilities for agriculture, forestry, wildlife, and recreation.

Stratification of the Survey Area

Based on the available information, the project area should be stratified according to the variables selected to meet the objectives of the survey. As an example, a survey to assess an areas' potential to grow trees (i.e., forest capability determination) may begin with a tentative delineation of climax forests. This information may be available from previous vegetation surveys or interpreted from forest cover maps. These areas could be further stratified into a range of edaphic conditions based on bedrock, topographic, and soil or landform information. A variety of stands of acceptable age classes could then be selected to form potential sampling areas.

Collecting data for other land use interpretations may require different stratification (e.g., for range management interpretations, range condition data may be needed, and for wildlife interpretation, the seral stages of the vegetation may be required).

The sampling layout should cover not only the range of recognized environmental variation, but also maintain a fairly complete geographic distribution within the project area to identify any previously unrecognized regional variation.

If insufficient information is available to stratify the project area prior to sampling, a field reconnaissance will be necessary to define the ranges of environmental variables and to assist the preparation of the sampling layout. The reconnaissance may include a number of elevational transects on various aspects throughout the project area. The type of reconnaissance information required is determined by the objectives of the survey.

Stratification allows identification and selection of available sampling areas, which may be classified as to accessibility (e.g., road or helicopter). The overall sampling plan should then be examined in relation to available resources for sampling, geographic distribution, and access, so that priority sampling areas can be identified.

Recommendations Concerning Data Collection

For those who plan statistical analyses of their data, three points should be noted:

1. Be consistent in data collection. If you are interested in examining the gravel content across a survey area, for example, make sure that you always estimate gravel content, or at least estimate it for a sufficiently large number of plots to make analysis worthwhile. Also, make sure that you will be able to make comparisons in a meaningful way! A comparison of percent gravel at the surface of one site with percent gravel of a deep horizon at another site is likely to be meaningless. It would be better to either specify a fixed depth interval to be sampled everywhere, or to always sample the parent material (C horizon). See the discussion under "Level" in Chapter Three.
2. Use an experimental design whenever possible. Before you begin the survey, carefully consider what types of comparisons or tests you will later want to make. It may be useful to discuss your plans in detail with someone familiar in statistical analysis. If any experimental design codes are required beyond those implied by the normal data on the forms, they can be entered into a free format field on the Site Description Form. For example, you may choose to sample on a grid basis, with the X coordinate ranging from 01 to 20 and the Y coordinate ranging from 01 to 20. The first two spaces under Plot No. on the Site Description Form can be used for the X coordinate and the next two spaces for the Y coordinate.
3. Indicate the sampling technique used in the survey. Item 53 on the Site Description Form is available for this purpose. This may be of significance to someone else analyzing your data and may affect the type of analysis or interpretation that is applied.

PLOT SELECTION

The appropriate selection of sampling sites determines the utility of all subsequent survey efforts and is especially important in medium and small scale surveys where the crew moves to a new area each day. Where a mapping unit is described by data from a single site, inappropriate site selection can lead to serious errors in map unit descriptions or identification. In larger-scale inventories, where mapping units are usually described by data from several sites, site selection is important, though not as critical, as at the smaller scales.

When choosing sites to describe and sample, the objectives must be clear. Random location may be the requirement in some cases but, more commonly, sites should be chosen by an objective selection process to represent mapping units, or to cover a specified range or combination of properties. In the latter cases, a clear statement of the nature of the criteria and features is necessary.

Sample plots should be homogeneous in soil and vegetation properties. Contrasting soil types in a vegetation plot or contrasting vegetation types in a soil plot should be avoided. Where repetitive or cyclical patterns occur over short distances, for example, in gullied or hummocky terrain, uniformity of plot conditions may be maintained by adjusting the shape of the plot boundaries.

Plot locations can be selected within the previously defined sampling areas by using aerial photographs. Aerial photographic interpretation can be used to confirm existing resource data. Slope position and landform interpretation can be used to estimate soil drainage and/or the moisture regime of the sampling area, and to locate specific sampling sites. Aerial photographs can also aid in locating helicopter landing sites.

Plot locations in accessible areas can be located on the ground prior to the actual sampling by field crews. Field crews operating from helicopters should always include a person experienced with plot location in the field.

The plot size is usually determined by the sampling techniques to be used. Many forested areas, for example, require a plot of at least 400 m^2 (0.04 ha) to provide an adequate description of the natural variation within a plant community. Grassland communities, however, can often be described adequately in a smaller plot. If forest mensuration data are collected by the methods described later in the manual, a plot area of at least 0.1 ha may be required. It is desirable to maintain a protective perimeter surrounding a plot area to avoid "edge" effects. Under natural conditions the perimeter can be fairly narrow (10-20 m), while plots adjacent to major disturbances (such as roads or cut blocks) may require a larger margin (40-50 m or more).

Within the plot area, environmental conditions should be relatively homogeneous. The plot should usually include a single soil polypedon and a single plant community, and be homogeneous with respect to environmental factors such as slope position, landform, texture, soil drainage, species composition or dominance, physiognomy, and stand structure. Plots that contain two easily distinguishable soil or vegetation types should be avoided.

Cyclical or repetitive variation must be evaluated relative to the size of each type and the size of the sample plot. For example, variation because of hummocky microtopography usually cannot be separated into two plots, whereas a series of rolling ridges can be separated into elongated plots.

Care should be taken that a soil pit located within a vegetation plot is representative of the conditions throughout the plot. This necessitates an examination of conditions over the entire plot area, to determine a "typical" location (in terms of surface substrate, microtopography, humus form thickness, surface texture, and so on).

Sampling adjacent to roads, buildings, or fence rows can often produce misleading information, since such sites may represent abnormal conditions. Samples from near a gravel road, for example, can reflect the influence of road dust, road drainage, and microclimatic influences. On the other hand, where past management practices have altered soil or vegetation properties over large areas, these changes should be described.

CLASSIFICATION CONCEPTS

Cline (1949) introduced the concepts of *differentiating*, *accessory*, and *accidental* characteristics to the classification of soils. These concepts are equally applicable to the classification of ecosystems, vegetation, and habitat for wildlife.

Differentiating characteristics are the attributes selected to distinguish or set apart classes. They should have as many accessory characteristics as possible.

Accessory characteristics are the attributes that are consistently associated with the differentiating characteristics. Accessory characteristics are sometimes used to identify classes when they can be readily observed and the differentiating characteristics cannot.

Accidental characteristics are attributes not consistently associated with the differentiating characteristics, but which may be important for certain purposes.

For example, we may wish to recognize a Cumquat soil (Cq) whose differentiating characteristics are a loamy-skeletal, moderately well drained, Duric Humo-Ferric Podzol, developed in morainal parent material. Any soil that fits this definition is a Cumquat soil. Accessory characteristics associated with the Cumquat soil may include particular vegetation features that aid in the recognition of this soil. Differentiating criteria chosen should carry as many useful accessory characteristics as possible. Accidental characteristics such as slope gradient may be important for management interpretations, and can either be described for the soil or incorporated into the map symbol for a mapping project. Some accidental characteristics, such as slope, are critical to subsequent management interpretations, and are therefore included as a differentiating criteria of mapping units.

During the initial reconnaissance phase of an inventory, the establishment of differentiating, accessory and accidental characteristics should be of prime importance, since they provide the basis for classification and on which subsequent strategies for plot selection are based.

When selecting sites (plots) at which to characterize specific ecosystems (habitats), soils, or vegetation types, a surveyor must ensure that all differentiating criteria of that type are met. The sites (plots) should also adequately represent the range of accessory and accidental characteristics covered by the ecosystem, soil, or vegetation types recognized.

In most surveys, at least one site (plot) of each recognized ecosystem, soil, or vegetation type should be fully sampled and described. Ideally, representative or modal descriptions should not be conducted until the end of the survey to ensure that the most representative sites are selected.

It should be noted that there is an increasing interest in statistically-based sampling. Most of the above discussion centres on modal or selective sampling for reconnaissance surveys where only limited sampling is done. Some surveyors feel that modal sampling may provide a misleading impression of precision, and that the range of conditions encountered are not adequately characterized. Where many samples can be obtained for various soil or ecosystem units, it may be more appropriate to use the data collected to establish means and ranges of properties.

HOW TO FILL OUT THE DATA FORMS

The field forms (except humus form) have been designed so that they can be sent directly to keypunch personnel for computer entry, provided they have been completed correctly and neatly. To accomplish this, first, read the *glossary* and the *general comments* (from Sondheim *et al.*, 1983) which follow. Next, examine the specific instructions for the individual field description forms, the item numbers as they appear on the field description forms, and the code symbols for the vegetation form. The field length, the field description, and comments about special characters or formats are provided where applicable. The possible entries are listed and defined in the manual.

Glossary

Field Length — The field length is the maximum number of characters that can be entered for a given item.

Type — Type refers to one of the following categories of data:

- *numeric* characters: these are to the ten digits from 0 to 9 inclusive. Decimal points are not included. Blanks are allowed if they lead a digit, as indicated by the following example: __ 1 0 and 0 1 0 are equivalent (the entry __ 1 __ is not allowed). Zeros or 'not blank' spaces should follow a decimal; for example, a depth of 10 cm should be entered as __ 1 0 . 0. Items 4 and 6 of the Site Description Form provide the only apparent exception to these rules.
- *alphabetic* characters: these are the 26 letters of the alphabet, plus the blank character.
- *alphanumeric* characters: these include all numeric and all alphabetic characters.
- *all possible* characters: these include all numeric and alphabetic characters, as well as special characters. The special characters that may be used are: * # % @ : ; , . ? ! ' " ( ) + − = < >.

Format — Format refers to one of the following two categories of data storage:

- *fixed*: in this case, the position of each character of the data element is directly connotative. All numeric entries, for example, are fixed. Fixed format data can be readily used in sorting or analytical procedures. Specific edit procedures can usually be established for fixed format data.
- *free*: in this case, the position of each character of the data element is not connotative. All "comments" or "notes" entries are free format. Free format data may appear in a report or description of a site, but often cannot be easily used in sorting or analytical procedures. Specific edit procedures usually cannot be established for free format data. An exception is that a certain number of the leading characters of a free format entry may be considered as fixed, if special arrangements are made prior to coding. Thus, with certain modifications, agricultural capability ratings, for example, may be entered as fixed format data in what normally would be a "Comments" or "Notes" item.

Justification — Justification is one of the following two forms of data entry:

- *left justified*: the data are entered beginning in the left-most part of the field. If, for example, the field length is 6 and the letters to be entered are ACK, then left justification would appear as follows: A C K __ __ __. Normally, alphabetic characters are left justified.
- *right justified*: the data are entered in the right-most part of the field. If, for example, the field length is 6 and the numbers to be entered are 115, then right justification appears as follows: __ __ __ 1 1 5. Normally, numeric characters are right justified. Fields that contain a decimal are always right justified for the integer part of the number. The fractional part of the number should always be completed; thus, a slope of 5% would be entered as __ __ __ 5 . 0 under Item 10 on the Site Description Form.

General Comments

Series and Form Number — Each field description form (soil, vegetation, etc.) *must* contain the same form number that is found on the associated Site Description Form. The form number *must* be right justified.

Decimal Points — For all fixed format entries on both the site and soil description forms, decimal points are supplied wherever allowed. On the vegetation form a decimal has been provided for stratum height in metres. However, for percent cover, values may range from 99 through 01 to 0.1. To enter values less than 01 percent, the surveyor may insert a decimal point.

Special Symbols — Special symbols (such as / # % , etc.) are *not* allowed in any numeric, alphabetic, or alphanumeric fields. Consequently, entries such as <25 or >50 are not permitted. This is discussed further under the appropriate items.

Letters and Print Style — The computer system stores all alphabetic characters as upper case. Coding can be accomplished using lower case letters, but they will not be entered as such. Printing should be neat and legible on all forms. The *letter O should always have slash through it*, but not the number "0". The letter "I" should always have bars on both the top and bottom (or, if lower case, be clearly dotted). The letter "L" should always make a right angle (or an elongated loop if lower case). If the coding is illegible, mistakes will be made during key entry and error messages will occur when the data is entered into the B.C. Soil Information System (BCSIS).

X — In certain fields, an "X" is entered to indicate that an item has been considered but not found. For numeric fields, the X is entered right-justified; for other fields, the X is left-justified. On the Site Description Form, the only places where this is pertinent is in Item 35, 'a' through 'g', and Item 38, the first entry. On the Soil Description Form, an X may be entered only in Items 12, 13, 18, 19, 20, 21, 22, and 23. Note that all of these locations are shaded. If neither an X nor a value is entered for any of these items, it is assumed that its presence or value has not been determined. The use of X is only relevant on the site and soil description forms.

Circled Items — It is recommended that circled items on the Site Description Form always be completed. If not completed, BCSIS will accept the form but will produce an error message indicating which circled items have been omitted.

Transaction Identifiers — The small characters on the left side of the site and soil description forms (ADDSOO, ADDSO1, etc.) are known as transaction identifiers. The identifier is key entered along with the series and form number and the appropriate data. The ADDSO1 transaction, for example, contains the identifier in the first six spaces, two blanks in the seventh and eighth spaces, the Series and Form Number in spaces 9 through 15, and the data for site items 1 through 6 (Proj. ID through UTM System) in spaces 16 through 101. Thus, ADDSO1 identifies in the computer that site data for items 1 through 6 are being added or entered, and that they are with reference to the given series and form number.

British Columbia Soil Information System (BCSIS)

The British Columbia Soil Information System (BCSIS) is a computer-based biophysical system incorporating site, morphological and laboratory data. These components of BCSIS are fully integrated in a Mark IV database structure. The Vegetation and Wildlife data described in this manual are housed in libraries outside of BCSIS but can be linked with data extracted from the 'Site/Soil' system for project analysis.

The main objectives of BCSIS are: to increase accessibility and reliability of soils information; to increase speed of map legend development; to increase the ability to integrate soils data with other resource data; and to aid in pedological and ecological modelling.

The system includes a number of easy-to-use functions related to data control, data management, and report generation. For data analysis, BCSIS is designed to be used in conjunction with the commercially available Statistical Analysis System (SAS). BCSIS resides on an IBM mainframe computer at the B.C. Systems Corporation, Victoria, but is accessible as well in other cities through the DATAPAC and SNA communications networks.

The data in BCSIS and ancillary biophysical data bases is representative of a broad spectrum of survey types and varied user communities. The data elements collected and 'dummy variables' used vary with project design. The data is collected on the ground and represents either "point sources" or small areas (plots).

CHAPTER 2

SITE DESCRIPTION

ADDS00 SERIES ☐☐ FORM ☐☐☐☐☐

SITE DESCRIPTION FORM

Parameters which must be filled are circled PAGE ______ OF ______

ADDS01 ① Proj. ID
2 Plot No
③ Date (Y M D)
④ NTS Sheet
⑤ Lat ° ' "
Long ° ' "
⑥ UTM System Zone Easting Northing

ADDS02 7 Location
8 Co-ord. Flight line Photo # X Y
⑨ Aspect
⑩ Slope %
⑪ Elevation : metres

ADDS03 12. Terrain Yr 19

	Texture	Gen. Mat.	Qual. Descr.	Surface Expression		Mod. Proc.	Qual. Descr.
1					-		
2							
3							

13 Phys. Sub.
14 Zone Subzone System
← BGC → V P
15 Ecological Classification System ← BGC → Assoc. S Type P

ADDS04 16. Vegetative Cover System
1 G S V 2 G S V 3 G S V 4 G S V

ADDS05 17. Soil Classif.
Yr 19
Phase
1
2
3
Family Particle Size ← 1 → ← 2 →

ADDS06 18. Plot representing

25 Site position diagram (refer to Series ☐☐ No ☐☐☐☐☐)

ADDS07

⑲ Site position macro
- a. apex
- b. face
- c. upper slope
- d. middle slope
- e. lower slope
- f. valley floor
- g. plain

⑳ Site position meso
- a. crest
- b. upper slope
- c. middle slope
- d. lower slope
- e. toe
- f. depression
- g. level

㉑ Site surface shape
- a. concave
- b. convex
- c. straight

㉒ Microtopography
- a. smooth
- b. micro mounded
- c. slightly mounded
- d. moderately mounded
- e. strongly mounded
- f. severely mounded
- g. extremely mounded
- h. ultra mounded

23. Meso slop length M

24. Meso up-slope length M

photo roll no

photo no

Direction

scale 1 = ______

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61086 ENV 1886

㉖ Exposure Type (allow 3)
39
a. not applicable
b. wind
c. insolation
d. frost
e. cold air drainage
f. saltspray
g. atmospheric toxicity

other 42

Comments 62

27 Ecological Moisture Regime
112
a. very xeric
b. xeric
c. subxeric
d. submesic
e. mesic
f. subhygric
g. hygric
h. subhydric
i. hydric

28 Nutrient Regime
113
a oligotrophic
b submesotrophic
c mesotrophic
d permesotrophic
e eutrophic
f hypereutrophic

29 Soil Temperature Class
114
a extremely cold
b very cold
c cold
d cool
e mild

30 Soil Moisture Subclass
115
a xeric
b arid
c subarid
d semiarid
e subhumid
f humid
g perhumid
h subaquic
i aquic
j per aquic

31 Soil drainage
116
a rapidly
b well
c mod. well
d imperfectly
e poorly
f very poorly

32 Perviousness
117
a rapidly
b moderately
c slowly

33 Free Water
118
a present
b absent

34 Flood hazard
119
a. frequent and irregular
b frequent
c may be expected
d rare
e no hazard

ADDS08

35 Depth to (cm)
16
a. water table
b rooting (effective)
c. root restricting layer
d. frozen layer
e. bedrock
f. carbonate
g. salinity
46

36 Bedrock type
47
1 →
2 →
86

37 Bedrock structure
51
90
124

38 Coarse fragment lithology type (in order of dominance)
125 — 1 → ← 2 → ← 3 →

if mixed (enter 1)
137

ADDS09

39 Successional Status
18
Present Stage: PS, YS, MS, OS, YEC, YCC, MCC, MEC, DC, NV

Expected climax
19

Rate of succession
49
a very slow
b slow
c normal
d rapid
e very rapid

40. Factors Influencing Stand Establishment
50 - 1 —— 2 —— 3 —— 4 ——
1 58
2 98
124

ADDS10

41. Veg. Plot: Area Shape # Dimensions
16
(ha) —— X —— x —— Y —— (m)

42 Humus Form Class
32

Variants

43 Surface Substrate

SUBSTRATE	% COVER
Decaying Wood	48
Bedrock	
Cobbles and Stones	
Mineral Soil	
Organic Matter	
Water	69
Total	100%

44. Profile Status
74
a. modal
b. variant
c. taxadjunct
d. undecided

45 Profile Deviation (allow 3)
75
a. none
b. solum thickness
c. colour
d. texture
e. drainage
f. chemical
g. horizon thickness
other 78

46 Soil Mapping Unit
98
a. series
b. family
c. associate
d. association
e. catena
f. complex
g. land system
h. land type
z. other

ADDS11

47. Soil name 16

48 Associated soil 36

49 Profile No 60

㊿ Project Coordinator 62

Surveyor 82 101

(51) Agency 107

(52) Type of Soil Sample
Chemical
115
a. full
b. partial

Physical
116
a. full
b. partial

53 Sampling Tech
117 124

ES 1000 RES 86-9

ADDS12

SERIES ☐☐ FORM ☐☐☐☐☐

SITE DESCRIPTION FORM

PAGE ____ OF ______

54. Notes on Site Description

16 26 36 46 56 66 REC.#
76 86 96 106 116 124 126 136
1

16
76 124
2

16
76 124
3

16
76 124
4

16
76 124
5

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Chapter Two

SITE DESCRIPTION

INTRODUCTION

The Site Description Form has two objectives: to describe landscape features associated with the survey plot, and to summarize features detailed on the soil and vegetation data forms for ease in compiling data. In order to meet the first objective, a number of landscape features such as elevation, aspect, slope, and topography must be determined and recorded. Items like "soil classification" and "vegetation type" synthesize the more detailed data presented on the soil and vegetation data forms.

The section, "How to Fill Out the Data Forms", in Chapter One must be understood. As stated there, all circled items on the site form should be completed. Field length refers to the maximum number of allowable character entries; field character refers to type of character (numeric, alphabetic, alphanumeric, and special characters); format refers to fixed or free; and justification is either left or right. Alphabetic character entries are left justified (i.e., data should be entered in the left-most part of the field), and numeric entries are right justified, unless otherwise noted. If no mention is made of field type, both alphanumeric and special characters are allowed.

SERIES AND FORM NUMBER

The Series and Form Number is either printed at the top left of the Site Description Form, or is a unique number assigned by the Soil Conservation Unit, Policy and Planning Branch, Ministry of Environment. The Series and Form Number are unique for each Site Description Form and are designed to eliminate confusion caused by multi-agency data collection. The numbers must be transferred to each soil, vegetation, humus form, mensuration, and wildlife description form used in conjunction with the Site Description Form.

1. PROJECT IDENTIFICATION (Proj. I.D.)

This field identifies the name of the project. It identifies all data forms relating to the specific project and should be unique for the project and identical on all forms. A maximum of 25 characters are allowed, however, it is recommended that the project code not exceed six characters for the purposes of computer retrieval. Field description is free format and left justified, with both alphanumeric and/or special characters allowed.

2. PLOT NUMBER (Plot No.)

A plot number may be assigned to each described site within the project area. This number is often used as a reference point and recorded on the aerial photographs or maps being used as part of the study. If more than one team is working within a project, a selected series of plot numbers, normally sequentially, is usually assigned to each team at the beginning of the survey. The main use of plot numbers is to facilitate plot relocation and communication amongst study team members. The Plot Number is unique within a particular project, but unlike the Series and Form Number, may not be unique between different projects. A maximum of 15 characters is allowed; field description is free format and left justified.

3. DATE (Y/M/D)

This field records the year/month/day on which the data on the form was gathered in the field. For example, June 26, 1986 translates as 8 6 / 0 6 / 2 6 .

4. NTS SHEET

This item identifies the mapsheet on which the described site is located. Guidelines for noting the mapsheet in the National Topographic (NTS), B.C. Series, or the B.C. Forest Service system are as follows:

NTS series or BC series — 1:125 000 or 1:100 000 scale

92F/NW __ 9 2 F | N W __ | __

NTS series or BC series — 1:50 000 scale

92F/4E __ 9 2 F | __ 4 E | __

BC Forest Service — 20 chain or 1:20 000 scale

92F/4-e __ 9 2 F | __ 4 __ | E

BC series — 1:20 000 scale

92F.057 __ 9 2 F | 0 5 7 | __

BC series — 1:10 000 scale

92F.057.2 __ 9 2 F | 0 5 7 | 2

5. LATITUDE (Lat.) AND LONGITUDE (Long.)

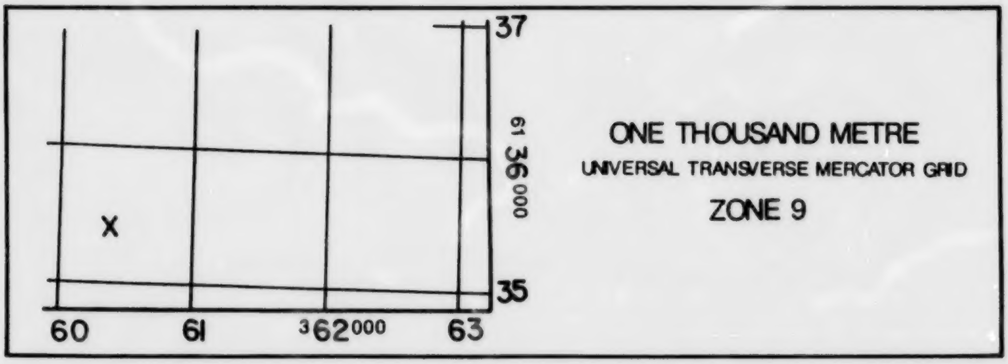
Latitude and longitude should, if possible, be noted to the nearest 10 seconds (± 5″). They are determined by locating the description site on the best available topographic base map and extracting the values from the map. Space is provided for noting degrees (°), minutes (′), and seconds (″). Space is also available for indicating the precision of the estimate (±), in seconds. UTM coordinates (see Item 6) can be identified as alternates for latitude and longitude.

6.UTM SYSTEM

The UTM System consists of zone, easting, and northing. The zone ranges from 8 to 11 in British Columbia and is entered right justified. Easting and northing are numeric entries *but* are entered left justified. For example, the location of the statue of Captain Vancouver at the Parliament Buildings in Victoria can be described as follows:

to the nearest metre	to the nearest km
Zone 1 0	Zone 1 0
Easting 4 7 2 7 0 3	Easting 4 7 3 __ __ __
Northing 5 3 6 2 8 0 6	Northing 5 3 6 3 __ __ __

The blue grid overprinted on many maps is the UTM system. The blue numbers near the corners of the map identify the full six and seven digit numbers for eastings and northings, respectively. The blue numbers along the map margins are not complete in that they are missing the first one or two digits.



The location of the "X" in the example is: Zone __ 9 Easting 3 6 0 3 __ __ Northing 6 1 3 5 4 __ __. Do not confuse the UTM system with the military grid reference system; the grid is the same for both, but the referencing is somewhat different. Also note that this is the only field on any of the forms where a fixed numeric entry is left justified.

7. LOCATION

These spaces allow for the recording of free-format information that will assist in relocating the site. Distance from permanent landmarks, compass bearings, and number of paces may be useful. However, care must be taken to select reference points which are unlikely to change (for example, some forests may be logged, or secondary roads relocated). A maximum of 78 characters can be recorded in the data file.

8. PHOTO NUMBER AND COORDINATES

Air photo number, with coordinates, is another method for recording site location and is often the most accurate. The flight line, photo number, and coordinates are recorded. The flight line is indicated on the aerial photographs and consists of two or more alphabetic characters followed by several numeric characters. It should be entered left justified. The photo number is also indicated on the aerial photograph as a three character number and is entered right justified.

The coordinates are determined by placing a plastic grid (Aerial Photo Grid 2M-79) over the aerial photograph, *with the photo aligned so that the photo number is viewed upright* and the axes of the grid aligned as shown in Figure 2.1 (the origin of the axes is in the lower left-hand corner of the air photo). It is imperative that the centre and fecucial points (those points at either the corners or centre of each side of the photograph) are aligned. The plastic grid can be obtained from MAPS — B.C., Ministry of Crown Lands, Parliament Buildings, Victoria, B.C. V8V 1X5.

Locate the description site on the aerial photograph and determine the closest point of intersecting X and Y grid lines. The values of the X and Y axes are then recorded (e.g., X — 14.8; Y — 9.4).

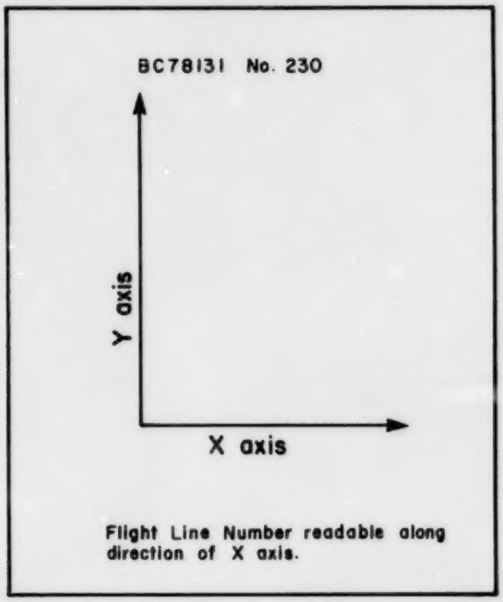


Figure 2.1 Orientation of X and Y axes for use with plastic coordinate grid overlay on aerial photograph

9. ASPECT

Aspect measures the orientation of a slope by means of compass points and indicates whether the slope is exposed to the north, south, east, or west, or any point between. It is valuable in predicting, when combined with slope gradient, the amount of incident solar radiation.

Level ground has no aspect, and the code is "999". If a slope is present, read the compass clockwise from east to south to west, and record the compass bearing. North is 0°, east is 90°, south is 180°, and west is 270°. Remember to adjust the compass declination for the amount appropriate to compensate for local magnetic variations.

10. SLOPE

Record the percent slope gradient of the land at the site using a clinometer or Abney level. The space after the decimal is usually zero unless very precise measurements are made. Table 2.1 provides the relationship between percent gradient and degrees of slope.

Table 2.1 Relationship between percent gradient and degrees of slope

Conversion from Percent Gradient to Degrees			Conversion from Degrees to Percent Gradient	
Percent	Degrees	and Minutes	Degrees	Percent
0	0°	00′	0°	0
5	2°	52′	2°	3.5
10	5°	43′	4°	7.0
15	8°	32′	6°	10.5
20	11°	19′	8°	14.0
25	14°	02′	10°	17.6
30	16°	42′	12°	21.2
35	19°	17′	15°	26.8
40	21°	48′	20°	36.4
50	26°	34′	25°	46.6
60	30°	58′	30°	57.7
70	34°	59′	35°	70.0
80	38°	39′	40°	83.9
90	41°	59′	45°	100.0
100	45°	00′	50°	119.2

11. ELEVATION

Record the elevation of the land at the site in metres. Determine it with an altimeter or, if need be, extract it from a topographic map. Conversion from feet to metres may be required (feet × 0.3048 = metres). An estimate of accuracy should be indicated and is usually to the nearest ± 5 or 10 m, depending on the instrument or map used.

12. TERRAIN

Space is provided for recording the various characteristics of the surficial material and landform of the site. Parameters that may be recorded include the texture, origin and surface expression (form) of the surficial material, and the geological process(es) that are modifying, or have modified, the site. Space is also provided for the description of up to two subsurface materials (stratigraphic layers). The parameters are defined in the revised "Terrain Classification System for British Columbia" (Howes and Kenk, 1988). Enter 1988 for the Terrain Year on the form.

Table 2.2 outlines the various terrain codes and their names used in the revised "Terrain Classification System for British Columbia". An example of how to record the information on the data form follows.

12. Terrain Yr.

16
19 | 8 | 7 |

	Texture	Gen. Mat.	Qual. Desc.	Surface Express		Mod. Proc.	Qual. Desc.
1	18 $	E		v		V	
2	29 s g	F	G	t	—	A	
3	40 d m			m			

The example describes a silty eolian veneer (< 1 m thick) that overlies a sandy gravel glaciofluvial terrace. The site is undergoing modification by active gully erosion and is subject to snow avalanches. Three modifying processes may be entered on the form. They refer to the unit as a whole, not to a specific stratigraphic layer. All entries are left justified.

Table 2.2 Terrain codes used in revised Terrain Classification System

TEXTURE

Clastic Terms

Code	*Name*	*Code*	*Name*
a	blocks	m	mud
b	boulders	p	pebbles
c	clay	r	rubble
d	mixed fragments	s	sand
g	gravel	$	silt
k	cobbles	x	angular fragments
		y	shells

Organic Terms

Code	*Name*
e	fibric
u	mesic
h	humic

GENETIC MATERIAL

Code	*Name*
A	Anthropogenic
C	Colluvial
D	Weathered Bedrock
E	Eolian
F	Fluvial
I	Ice
L	Lacustrine
M	Morainal (Till)
O	Organic
R	Bedrock
U	Undifferentiated
V	Volcanic
W	Marine

SURFACE EXPRESSION

Code	*Name*
a	moderate slope
b	blanket
c	cone(s)
d	depression(s)
f	fan(s)
h	hummock(s)
j	gentle slope
k	moderately steep slope
m	rolling
p	plain
r	ridge(s)
s	steep slope
t	terrace(s)
u	undulating
v	veneer

MODIFYING PROCESSES

Code	*Name*	*Code*	*Name*
A	snow avalanches	M	meandering channel
B	braiding channel	N	nivation
C	cryoturbation	P	piping
D	deflation	R	rapid mass movement
E	meltwater channel	S	solifluction
F	slow mass movement	U	inundated terrain
H	kettled	V	gully erosion
I	irregularly sinuous channel	W	washing
J	anastamosing channel	X	permafrost processes
K	karst processes	Z	general periglacial processes

QUALIFYING DESCRIPTORS

Code	*Name*
A	active
I	inactive
G	glacial

13. PHYSIOGRAPHIC SUBDIVISION

Physiographic subdivisions are designated according to "Landforms of British Columbia" (Holland, 1976). Table 2.3 outlines the subdivisions and codes to be used. When recording this parameter, the most detailed subdivision should be indicated (i.e., rather than simply recording Insular Mountains, code either 1212 for Queen Charlotte Ranges or 1221 for Vancouver Island Ranges).

Table 2.3 Physiographic subdivisions of British Columbia (from Holland, 1976)*

WESTERN SYSTEM	1. OUTER MOUNTAIN AREA	1. ST. ELIAS MOUNTAINS	0.	1. FAIRWEATHER RANGES 2. ICEFIELD RANGES 3. ALSEK RANGES 4. DUKE DEPRESSION
		2. INSULAR MOUNTAINS	1. QUEEN CHARLOTTE MOUNTAINS	1. SKIDEGATE PLATEAU 2. QUEEN CHARLOTTE RANGES
			2. VANCOUVER ISLAND MOUNTAINS	1. VANCOUVER ISLAND RANGES 2. ALBERNI BASIN 3. ESTEVAN COASTAL PLAIN
	2. COASTAL TROUGH	1. HECATE DEPRESSION	1. QUEEN CHARLOTTE LOWLAND	0. 1. ARGONAUT PLAIN
			2. NAHWITTI LOWLAND	0. 1. SUQUASH BASIN
			3. HECATE LOWLAND	0. 1. MILBANKE STRANDFLAT
		2. GEORGIA DEPRESSION	1. GEORGIA LOWLAND	0. 1. FRASER LOWLAND
			2. NANAIMO LOWLAND	0.
INTERIOR SYSTEM	3. COAST MOUNTAIN AREA	1.COAST MOUNTAINS	1. BOUNDARY RANGES 2. KITIMAT RANGES	0.
			3. PACIFIC RANGES	0. 1. CHILCOTIN RANGES
		2. CASCADE MOUNTAINS	0. 1. SKAGIT RANGE 2. HOZAMEEN RANGE 3. OKANAGAN RANGE	0.
	4. NORTHERN PLATEAU AND MOUNTAIN AREA	1. YUKON PLATEAU	1. TAGISH HIGHLAND 2. TESLIN PLATEAU 3. NISUTLIN PLATEAU	0.
		2. LIARD PLAIN	0.	0.
	5. CENTRAL PLATEAU AND MOUNTAIN AREA	1. STIKINE PLATEAU	1. TAHLTAN HIGHLAND 2. TAKU PLATEAU	0.
			3. KAWDY PLATEAU	0. 1. ATSUTLA RANGE
			4. NAHLIN PLATEAU 5. TANZILLA PLATEAU 6. KLASTLINE PLATEAU 7. SPATSIZI PLATEAU	0.
		2. SKEENA MOUNTAINS	0. 1. KLAPPAN RANGE 2. TATLATUI RANGE 3. EAGLENEST RANGE 4. SICINTINE RANGE 5. SLAMGEESH RANGE	0.
		3. NASS BASIN	0.	0.
		4. HAZELTON MOUNTAINS	1. NASS RANGES 2. KISPIOX RANGE 3. BULKLEY RANGES 4. TAHTSA RANGES	0.
		5. CASSIAR MOUNTAINS	1. DEASE PLATEAU 2. STIKINE RANGES 3. KECHIKA RANGES 4. SIFTON RANGES	0.
		6. OMINECA MOUNTAINS	1. SWANNELL RANGES 2. FINLAY RANGES 3. HOGEM RANGES	0.
	6. ROCKY MOUNTAIN TRENCH	0.	0.	0.
	7. SOUTHERN PLATEAU AND MOUNTAIN AREA	1. INTERIOR PLATEAU	1. FRASER BASIN	0. 1. NECHAKO PLAIN
			2. NECHAKO PLATEAU	0. 1. McGREGOR PLATEAU
			3. FRASER PLATEAU 4. THOMPSON PLATEAU 5. QUESNEL HIGHLAND 6. SHUSWAP HIGHLAND 7. OKANAGAN HIGHLAND	0.
		2. COLUMBIA MOUNTAINS	1. SELKIRK MOUNTAINS 2. CARIBOO MOUNTAINS 3 PURCELL MOUNTAINS 4. MONASHEE MOUNTAINS	0.
	8. McKENZIE MOUNTAIN AREA	1. LIARD PLATEAU	0	0.
EASTERN SYSTEM	9. ROCKY MOUNTAIN AREA	1. ROCKY MOUNTAINS	1. BORDER RANGES	1. GALTON RANGE 2. MACDONALD RANGE 3. CLARK RANGE 4. FLATHEAD BASIN
			2. CONTINENTAL RANGES	1. FRONT RANGES 2. KOOTENAY RANGES 3. PARK RANGES
			3. HART RANGES	1. MISINCHINKA RANGES
			4. MUSKWA RANGES	1. RABBIT PLATEAU
		2. ROCKY MOUNTAIN FOOTHILLS	0.	0.
	0. INTERIOR PLAINS	1. ALBERTA PLATEAU	0. 1. FORT NELSON LOWLAND	0.

* Numeric codes should be used on the Site Description Form (e.g., 1223 identifies Estevan Coastal Plain; 3120 indicates Kitimat Ranges).

14. ZONE/SUBZONE/ECOREGION

The name of any vegetation zone and subzone can be recorded here, however, the Ministry of Forests' biogeoclimatic unit codes (see Table 2.4) are usually entered. The surveyor must ensure proper identification of the classification scheme employed, or indicate a reference to the classification scheme. A code for the agency name (see Item 51), or author and date of reference, should be indicated. The usual entry will be M F R S __ starting in space 55 (left justified) for Ministry of Forests' Research Section.

The biogeoclimatic zone, subzone, variant (V), and phase (P) are entered, left justified, under BGC as follows:

BGC							
						V	P
C	W	H		m	m	1	b

Up to four alphabetic characters can be coded for zone and up to two for subzone, while one numeric character and one alphabetic character are allowed for variant (V) and phase (P), respectively. The example (using Table 2.4) indicates the Coastal Western Hemlock (CWH) Zone, Moist Maritime (mm) Subzone, Submontane (1) Variant, "b" phase. Table 2.4 contains the codes and names currently (1990) in use in the province. Historic codes are also given for continuity. Parkland subzones of the ESSF and MH (coded as 'p') and scrub subzones of the SWB ('s') are coded under 'phase'.

Table 2.4 Biogeoclimatic units of British Columbia

Zone	Subzone	Variant	Name	Old Code
AT			**Alpine Tundra Zone** (no subzones presently recognized)	
BG			**Bunchgrass Zone**	
	BGxh		Very Dry Hot BG	
		BGxh1	Okanagan BGxh	PPBGa3 or BGa3
		BGxh2	Thompson BGxh	PPBGa1 or BGa1
		BGxh3	Fraser BGxh	PPBGg or BGg
	BGxw		Very Dry Warm BG	
		BGxw1	Nicola BGxw	PPBGm or BGm
		BGxw2	Alkali BGxw	PPBGe or BGe
BWBS			**Boreal White and Black Spruce Zone**	
	BWBSdk		Dry Cool BWBS	
		BWBSdk1	Stikine BWBSdk	BWBSe
		BWBSdk2	Liard BWBSdk	BWBSa2
	BWBSmw2		Moist Warm BWBS	
		BWBSmw1	Peace BWBSmw	BWBSc1, c2
		BWBSmw2	Fort Nelson BWBSmw	BWBSa1
	BWBSwk		Wet Cool BWBS	
		BWBSwk1	Murray BWBSwk	BWBSd1
		BWBSwk2	Graham BWBSwk	BWBSd2
		BWBSwk3	Kledo BWBSwk	BWBSb
CDF			**Coastal Douglas-fir Zone**	
	CDFmm		Moist Maritime CDF	CDFa

Table 2.4 Biogeoclimatic units of British Columbia — *Continued*

Zone	Subzone	Variant	Name	Old Code
CWH			**Coastal Western Hemlock Zone**	
	CWHxm		Very Dry Maritime CWH	
		CWHxm1	Eastern CWHxm	CDFb
		CWHxm2	Western CWHxm	CWHa1
	CWHdm		Dry Maritime CWH	CWHa2
	CWHds		Dry Submaritime CWH	
		CWHds1	Southern CWHds	CWHc1
		CWHds2	Central CWHds	CWHc2, h1, h2
	CWHmm		Moist Maritime CWH	
		CWHmm1	Submontane CWHmm	CWHb3
		CWHmm2	Montane CWHmm	CWHb4
	CWHms		Moist Submaritime CWH	
		CWHms1	Southern CWHms	CWHb5
		CWHms2	Central CWHms	CWHb6, h3
	CWHwh		Wet Hypermaritime CWH	
		CWHwh1	Submontane CWHwh	CWHe1, g1
		CWHwh2	Montane CWHwh	CWHe2, g2
	CWHws		Wet Submaritime CWH	
		CWHws1	Submontane CWHws	CWHf1
		CWHws2	Montane CWHws	CWHf2, i3, b7
	CWHvh		Very Wet Hypermaritime CWH	
		CWHvh1	Outer CWHvh	CWHd, CCPH
		CWHvh2	Inner CWHvh	CWHd, CCPH
	CWHvm		Very Wet Maritime CWH	
		CWHvm1	Submontane CWHvm	CWHb1, i1
		CWHvm2	Montane CWHvm	CWHb2, i2
ESSF			**Engelmann Spruce — Subalpine Fir Zone**	
	ESSFxc		Very Dry Cold ESSF	ESSFd
	ESSFdk		Dry Cool ESSF	ESSFa
	ESSFdc		Dry Cold ESSF	
		ESSFdc1	Okanagan ESSFdc	ESSFe2
		ESSFdc2	Thompson ESSFdc	ESSFe1
	ESSFdv		Dry Very Cold ESSF	ESSFe3
	ESSFmw		Moist Warm ESSF	ESSFf
	ESSFmm		Moist Mild ESSF	ESSFo
		ESSFmm1	Raush ESSFmm	
		ESSFmm2	Robson ESSFmm	
	ESSFmk		Moist Cool ESSF	ESSFl
	ESSFmc		Moist Cold ESSF	ESSFk
	ESSFmv		Moist Very Cold ESSF	
		ESSFmv1	Nechako ESSFmv	ESSFv
		ESSFmv2	Bullmoose ESSFmv	ESSFn1
		ESSFmv3	Omineca ESSFmv	ESSFn3
		ESSFmv4	Graham ESSFmv	ESSFn2
	ESSFwm		Wet Mild ESSF	ESSFc (eastern portion)
	ESSFwk		Wet Cool ESSF	
		ESSFwk1	Quesnel ESSFwk	ESSFh1
		ESSFwk2	Misinchinka ESSFwk	ESSFh3 (lower elevations)
	ESSFwc		Wet Cold ESSF	
		ESSFwc1	Selkirk ESSFwc	ESSFc (western portion)
		ESSFwc2	Northern Monashee ESSFwc	ESSFm
		ESSFwc3	Cariboo ESSFwc	ESSFh2 ESSFh3 (upper elevations)
	ESSFwv		Wet Very Cold ESSF	ESSFi
	ESSFvc		Very Wet Cold ESSF	ESSFb, w
	ESSFvv		Very Wet Very Cold ESSF	ESSFu

Table 2.4 Biogeoclimatic units of British Columbia — *Continued*

Zone	Subzone	Variant	Name	Old Code
ICH			**Interior Cedar — Hemlock Zone**	
	ICHxw		Very Dry Warm ICH	ICHd
	ICHdw		Dry Warm ICH	ICHa1
	ICHdk		Dry Cool ICH	ICHe3
	ICHmw		Moist Warm ICH	
		ICHmw1	Columbia ICHmw	ICHa2 (southern and central part)
		ICHmw2	Shuswap ICHmw	ICHm2
		ICHmw3	Thompson ICHmw	ICHm1
		ICHmw4	Golden ICHmw	ICHa2 (northern part)
	ICHmm		Moist Mild ICH	ICHj
	ICHmk		Moist Cool ICH	
		ICHmk1	Kootenay ICHmk	ICHc, MSe
		ICHmk2	Thompson ICHmk	ICHe1
		ICHmk3	Horsefly ICHmk	ICHe2
	ICHmc		Moist Cold ICH	
		ICHmc1	Nass ICHmc	ICHg1
		ICHmc2	Hazelton ICHmc	ICHg2, 3
	ICHwk		Wet Cool ICH	
		ICHwk1	Wells Gray ICHwk	ICHw, h1, b (southern portion)
		ICHwk2	Cariboo ICHwk	ICHh2
		ICHwk3	Goat ICHwk	ICHk
	ICHvk		Very Wet Cool ICH	
		ICHvk1	Mica ICHvk	ICHb (northern portion), v
		ICHvk2	Slim ICHvk	ICHf
	ICHvc		Very Wet Cold ICH	
		ICHvc1	Meziadin ICHvc	ICHg4
		ICHvc2	Iskut ICHvc	ICHg5
IDF			**Interior Douglas-fir Zone**	
	IDFxh		Very Dry Hot IDF	
		IDFxh1	Okanagan IDFxh	IDFa3
		IDFxh2	Thompson IDFxh	IDFa1
	IDFxw		Very Dry Warm IDF	IDFa2
	IDFxm		Very Dry Mild IDF	IDFa4
	IDFdm		Dry Mild IDF	
		IDFdm1	Kettle IDFdm	IDFf
		IDFdm2	Kootenay IDFdm	IDFg3
	IDFdk		Dry Cool IDF	
		IDFdk1	Thompson IDFdk	IDFb1, b4
		IDFdk2	Cascade IDFdk	IDFb3, d
		IDFdk3	Fraser IDFdk	IDFb2
		IDFdk4	Chilcotin IDFdk	IDFb5
	IDFmw		Moist Warm IDF	
		IDFmw1	Okanagan IDFmw	IDFj2
		IDFmw2	Thompson IDFmw	IDFj1
	IDFww		Wet Warm IDF	IDFe

Table 2.4 Biogeoclimatic units of British Columbia — *Continued*

Zone	Subzone	Variant	Name	Old Code
MH			**Mountain Hemlock Zone**	
	MHmm		Moist Maritime MH	
		MHmm1	Windward MHmm	MHa, d
		MHmm2	Leeward MHmm	MHb, e
	MHwh		Wet Hypermaritime MH	
		MHwh1	Windward MHwh	MHc1
		MHwh2	Leeward MHwh	MHc2, f
	MHmp		Moist Maritime Parkland MH	
		MHmmp1	Windward MHmmp	MHap, dp
		MHmmp2	Leeward MHmmp	MHbp, ep
	MHwhp		Wet Hypermaritime Parkland MH	
		MHwhp1	Windward MHwhp	MHcp1
		MHwhp2	Leeward MHwhp	MHcp2, fp
MS			**Montane Spruce Zone**	
	MSxk		Very Dry Cool MS	MSc
	MSxv		Very Dry Very Cold MS	MSd
	MSdm		Dry Mild MS	
		MSdm1	Okanagan MSdm	MSb2
		MSdm2	Thompson MSdm	MSb1
	MSdk		Dry Cool MS	MSa
	MSdc		Dry Cold MS	MSb4
PP			**Ponderosa Pine Zone**	
	PPxh		Very Dry Hot PP	
		PPxh1	Okanagan PPxh	PPd2 or PPBGd2
		PPxh2	Thompson PPxh	PPd1 or PPBGd1
	PPdh		Dry Hot PP	
		PPdh1	Kettle PPdh	PPc or PPBGc
		PPdh2	Kootenay PPdh	IDFg2
SBPS			**Sub-Boreal Pine — Spruce Zone**	
	SBPSxc		Very Dry Cold SBPS	SBSa1
	SBPSdc		Dry Cold SBPS	SBSa3
	SBPSmk		Moist Cool SBPS	SBSb
	SBPSmc		Moist Cold SBPS	SBSa2

Table 2.4 Biogeoclimatic units of British Columbia — *Continued*

Zone	**Subzone**	**Variant**	**Name**	**Old Code**
SBS			**Sub-Boreal Spruce Zone**	
	SBSdh		Dry Hot SBS	SBSh
		SBSdh1	McLennan SBSdh	
		SBSdh2	Robson SBSdh	
	SBSdw		Dry Warm SBS	
		SBSdw1	Horsefly SBSdw	SBSk1
		SBSdw2	Blackwater SBSdw	SBSk2
		SBSdw3	Stuart SBSdw	SBSk3
	SBSdk		Dry Cool SBS	SBSd
	SBSmh		Moist Hot SBS	SBSl
	SBSmw		Moist Warm SBS	SBSc
	SBSmm		Moist Mild SBS	SBSm1
	SBSmk		Moist Cool SBS	
		SBSmk1	Mossvale SBSmk	SBSe2
		SBSmk2	Williston SBSmk	SBSo
	SBSmc		Moist Cold SBS	
		SBSmc1	Moffat SBSmc	SBSm2
		SBSmc2	Babine SBSmc	SBSe1, e (Cariboo Region)
		SBSmc3	Kluskus SBSmc	SBSi
	SBSwk		Wet Cool SBS	
		SBSwk1	Willow SBSwk	SBSj1
		SBSwk2	Finlay-Peace SBSwk	SBSj2
		SBSwk3	Takla SBSwk	SBSn
	SBSvk		Very Wet Cool SBS	SBSf
SWB			**Spruce — Willow — Birch Zone**	
	SWBdk		Dry Cool SWB	SWBa
	SWBdks		Dry Cool Scrub SWB	SWBas
	SWBmk		Moist Cool SWB	SWBb, f
	SWBmks		Moist Cool Scrub SWB	SWBbs, s

If another system of zone/subzone classification is applied, be sure to identify the "system" used as described previously, and enter the appropriate symbols on the Site Description Form, left justified (i.e., start in space 60 to the left of the BGC arrow of Transaction Identifier ADDS03).

Ecoregions and ecosections have been defined and mapped by Demarchi (1988) as shown in Figure 2.2. The appropriate ecosection can be recorded beginning in space 60 using one of the three letter codes determined from Figure 2.2 (and listed in Table 2.5).

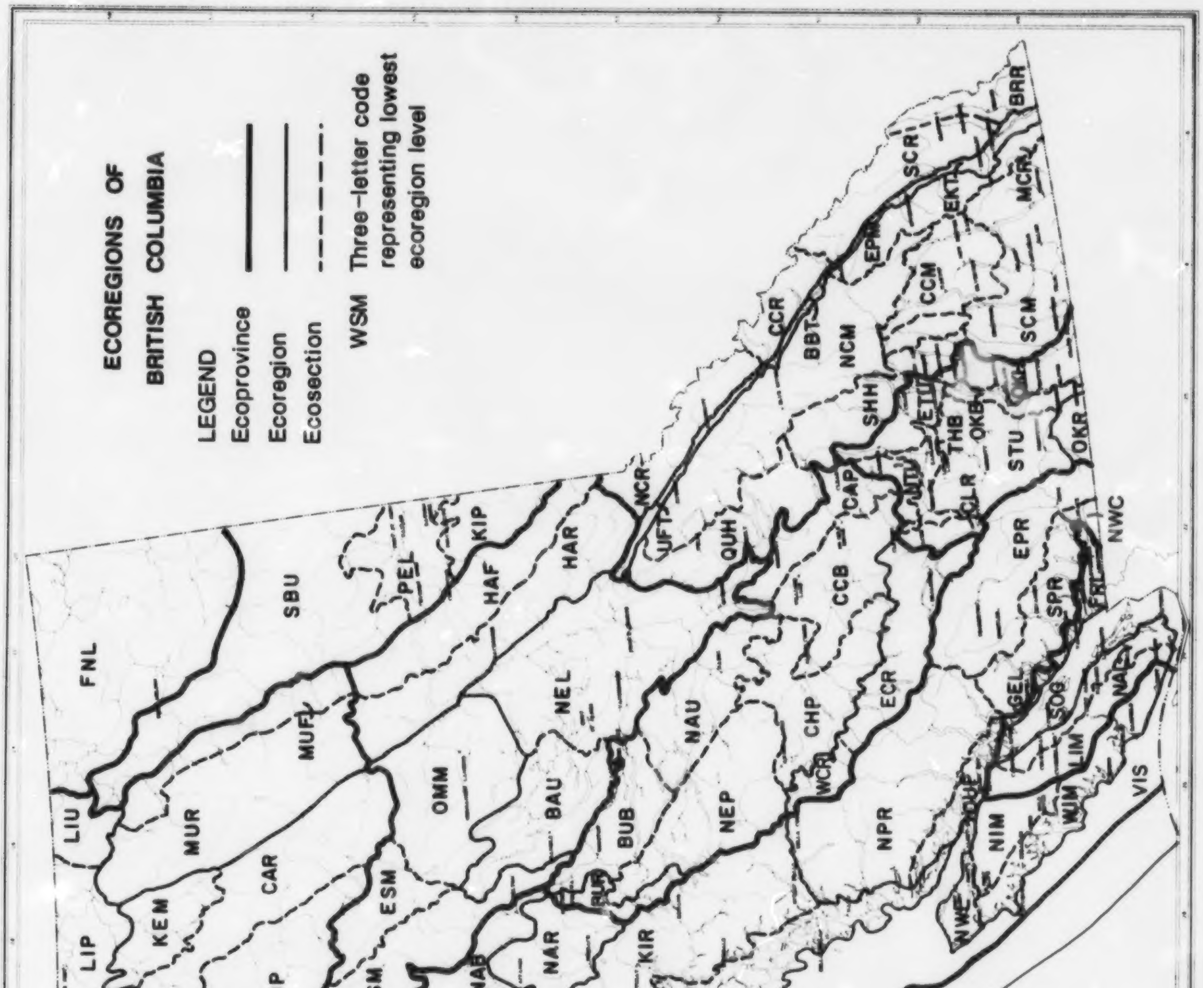

ECOREGIONS OF BRITISH COLUMBIA
LEGEND
Ecoprovince
Ecoregion
Ecosection
WSM Three-letter code representing lowest ecoregion level
ICR
TAB
ALR
TAH
TEP
THH
TUR
STP
BOR
LIP
SBP
WSM
NAB
KEM
CAR
ESM
LIU
MUR
OMM
MUF
FNL
SBU
PEL
KIP
HAF
HAR
NCR
NEL
BAU
BUB
RUP
NAR
KIR
HEL
HED
WQC
SKP
QCL
DIE
COR
COS
NAU
NEP
NPR
CHP
WCR
CCB
ECR
QUH
UFT
CAP
SHH
BBT
CCR
NCM
EPM
SCR
BRR
EKT
MCR
CCM
SCM
THB
OKB
STU
OKR
CLR
EPR
NWC
SPR
FRL
GEL
SOG
NAL
LIM
WIM
NIM
NWC
VIS

Figure 2.2 Ecoregions of British Columbia (after Demarchi, 1988)

Table 2.5 Codes and names for Ecoregions of British Columbia (see Figure 2.2)

Ecoprovince	Ecoregion	Ecosection	Code
Boreal Plains	Alberta Plateau	Kitskatinaw Plateau	KIP
		Peace Lowland	PEL
		Sikanni-Beatton Plateau	SBU
Central Interior	Bulkley Ranges	—	BUR
	Chilcotin Ranges	Eastern Chilcotin Ranges	ECR
		Western Chilcotin Ranges	WCR
	Fraser Plateau	Bulkley Basin	BUB
		Cariboo Plateau	CAP
		Chilcotin-Cariboo Basin	CCB
		Chilcotin Plateau	CHP
		Nazko Upland	NAU
		Nechako Plateau	NEP
Coast and Mountains	Coastal Gap	Hecate Lowland	HEL
		Kitimat Ranges	KIR
	Continental Shelf	Dixon Entrance	DIE
		Hecate Depression	HED
		Vancouver Island Shelf	VIS
	Nass Basin	—	NAB
	Nass Ranges	—	NAR
	Northern Coast and Mountains	Alsek Ranges	ALR
		Boundary Ranges	BOR
	Pacific and Cascade Ranges	Eastern Pacific Ranges	EPR
		Northern Pacific Ranges	NPR
		Northwestern Cascade Ranges	NWC
		Outer Fiordland	OUF
		Southern Pacific Ranges	SPR
	Queen Charlotte Lowland	—	QCL
	Queen Charlotte Ranges	Skidegate Plateau	SKP
		Windward Queen Charlotte Mountains	WQC
	Western Vancouver Island	Northern Island Mountains	NIM
		Nahwitti Lowland	NWL
		Windward Island Mountains	WIM
Georgia Depression	Eastern Vancouver Island	Leeward Island Mountains	LIM
		Nanaimo Lowland	NAL
	Lower Mainland	Fraser Lowland	FRL
		Georgia Lowland	GEL
	Strait of Georgia	—	SOG
Northeast Pacific	Continental Rise	—	COR
	Continental Slope	—	COS

Table 2.5 Codes and names for Ecoregions of British Columbia (see Figure 2.2) — *Continued*

Ecoprovince	**Ecoregion**	**Ecosection**	**Code**
Northern Boreal Mountains	Icefield Ranges	—	ICR
	Liard Basin	Liard Plain	LIP
		Liard Upland	LIU
	Northern Mountains and Plateaus	Cassiar Ranges	CAR
		Kechika Mountains	KEM
		Southern Boreal Plateau	SBP
		Stikine Plateau	STP
		Teslin Plateau	TEP
		Tuya Range	TUR
	Northern Rocky Mountains	Muskwa Foothills	MUF
		Muskwa Ranges	MUR
	Tatshenshini Basin	—	TAB
	Yukon-Stikine Highlands	Tagish Highland	TAH
		Tahltan Highland	THH
Southern Interior	Okanagan Ranges	—	OKR
	Thompson-Okanagan Plateau	Clear Range	CLR
		Eastern Thompson Upland	ETU
		Northern Thompson Upland	NTU
		Okanagan Basin	OKB
		Okanagan Highland	OKH
		Southern Thompson Upland	STU
		Thompson Basin	THB
Southern Interior Mountains	Columbia Mountains and Highlands	Central Columbia Mountains	CCM
		Eastern Purcell Mountains	EPM
		McGillivary Range	MCR
		Northern Columbia Mountains	NCM
		Quesnel Highland	QUH
		Southern Columbia Mountains	SCM
		Shuswap Highland	SHH
	Southern Rocky Mountains	Border Ranges	BRR
		Central Continental Ranges	CCR
		Northern Continental Ranges	NCR
		Southern Continental Ranges	SCR
	Southern Rocky Mountain Trench	Big Bend Trench	BBT
		East Kootenay Trench	EKT
		Upper Fraser Trench	UFT
Sub-Boreal Interior	Central Rocky Mountains	Hart Foothills	HAF
		Hart Ranges	HAR
	Fraser Basin	Babine Upland	BAU
		Nechako Lowland	NEL
	Skeena and Omineca Mountains	Eastern Skeena Mountains	ESM
		Omineca Mountains	OMM
		Western Skeena Mountains	WSM
Taiga Plains	Fort Nelson Lowland	—	FNL

15. ECOLOGICAL CLASSIFICATION

The name of the ecosystem described is recorded here. One of the standard codes (see Item 51) for the agency name (or author and date of reference) should be used for the classification system. The usual entry will be M F R S __ starting in space 77 (left justified) for Ministry of Forests' Research Section. The name of the ecosystem is often determined following data synthesis, and may not be available at the time of field sampling. It should be added to the data base when it becomes available.

The ecosystem units in the Ministry of Forests' biogeoclimatic system should be coded as follows: Association (Assoc.), up to two numeric characters (right justified); Subassociation (S), one numeric character; Type, up to two numeric characters (right justified); and Phase (P), one alphabetic character.

If another system of ecological classification is applied, be sure to enter the "system" used as previously described, and enter the appropriate symbols.

16. VEGETATIVE COVER

Vegetative cover is any class defined by the composition of the vegetation. The term may be applied to either the community type, to the plant association, or to any other level of vegetation classification. Under "system", enter the appropriate agency or reference (e.g., author and year), for example, M F I __ __ starting in space 16 (left justified) for Ministry of Forests' inventory maps, or M C L 7 0 for McLean's (1970) "Plant Communities of the Similkameen Valley". Up to four plants may be entered, using abbreviations given in the "Vegetation Coding List" (Titus, 1980) compiled by the Ministry of Forests. Usually, the coding is the first four letters of the genus name (g) and first three of the species (s), although some exceptions do exist to eliminate duplication. Subspecies or variety (v), if determined, are noted by a numeric code. For example, *Ceanothus velutinus* var *laevigatus* is coded C E A N V E L 1.

17. SOIL CLASSIFICATION

Taxonomic soil classification is according to the Canadian System of Soil Classification (Expert Committee on Soil Survey, 1987). Either soil great group or soil subgroup may be entered. Since the soil classification has, and is undergoing periodic changes, indicate the *year* of the classification system used (e.g. enter 8 7 for 1987). The subgroup descriptor code is recorded right justified before the period, and the great group code is recorded left justified after the period (e.g., __ __ __ R . G __ __ for Rego Gleysol). Soil subgroup codes are supplied in Table 2.6. Note that the Folisol Great Group has been expanded to four subgroups.

Table 2.6 Soil subgroup codes and names

Brunisolic Order

Orthic Melanic Brunisol O.MB
Eluviated Melanic Brunisol E.MB
Gleyed Melanic Brunisol GL.MB
Gleyed Eluviated Melanic Brunisol GLE.MB

Orthic Eutric Brunisol O.EB
Eluviated Eutric Brunisol E.EB
Gleyed Eutric Brunisol GL.EB
Gleyed Eluviated Eutric Brunisol GLE.EB

Orthic Sombric Brunisol O.SB
Eluviated Sombric Brunisol E.SB
Duric Sombric Brunisol DU.SB
Gleyed Sombric Brunisol GL.SB
Gleyed Eluviated Sombric Brunisol GLE.SB

Orthic Dystric Brunisol O.DYB
Eluviated Dystric Brunisol E.DYB
Duric Dystric Brunisol DU.DYB
Gleyed Dystric Brunisol GL.DYB
Gleyed Eluviated Dystric Brunisol GLE.DYB

Chernozemic Order

Orthic Brown O.B
Rego Brown R.B
Calcareous Brown CA.B
Eluviated Brown E.B
Solonetzic Brown SZ.B
Gleyed Brown GL.B
Gleyed Rego Brown GLR.B
Gleyed Calcareous Brown GLCA.B
Gleyed Eluviated Brown GLE.B
Gleyed Solonetzic Brown GLSZ.B

Table 2.6 Soil subgroup codes and names — *Continued*

Orthic Dark Brown O.DB
Rego Dark Brown R.DB
Calcareous Dark Brown CA.DB
Eluviated Dark Brown E.DB
Solonetzic Dark Brown SZ.DB
Gleyed Dark Brown GL.DB
Gleyed Rego Dark Brown GLR.DB
Gleyed Calcareous Dark Brown GLCA.DB
Gleyed Eluviated Dark Brown GLE.DB
Gleyed Solonetzic Dark Brown GLSZ.DB

Orthic Black O.BL
Rego Black R.BL
Calcareous Black CA.BL
Eluviated Black E.BL
Solonetzic Black SZ.BL
Gleyed Black GL.BL
Gleyed Rego Black GLR.BL
Gleyed Calcareous Black GLCA.BL
Gleyed Eluviated Black GLE.BL
Gleyed Solonetzic Black GLSZ.BL

Orthic Dark Gray O.DG
Rego Dark Gray R.DG
Calcareous Dark Gray CA.DG
Solonetzic Dark Gray SZ.DG
Gleyed Dark Gray GL.DG
Gleyed Rego Dark Gray GLR.DG
Gleyed Calcareous Dark Gray GLCA.DG
Gleyed Solonetzic Dark Gray GLSZ.DG

Cryosolic Order

Orthic Turbic Cryosol O.TC
Brunisolic Turbic Cryosol BR.TC
Regosolic Turbic Cryosol R.TC
Gleysolic Turbic Cryosol GL.TC

Orthic Static Cryosol O.SC
Brunisolic Static Cryosol BR.SC
Regosolic Static Cryosol R.SC
Gleysolic Static Cryosol GL.SC

Fibric Organic Cryosol FI.OC
Mesic Organic Cryosol ME.OC
Humic Organic Cryosol HU.OC
Terric Fibric Organic Cryosol TFI.OC
Terric Mesic Organic Cryosol TME.OC
Terric Humic Organic Cryosol THU.OC
Glacic Organic Cryosol GC.OC

Gleysolic Order

Orthic Humic Gleysol O.HG
Rego Humic Gleysol R.HG
Fera Humic Gleysol FE.HG
Solonetzic Humic Gleysol SZ.HG

Orthic Gleysol O.G
Rego Gleysol R.G
Fera Gleysol FE.G
Solonetzic Gleysol SZ.G

Orthic Luvic Gleysol O.LG
Humic Luvic Gleysol HU.LG
Fera Luvic Gleysol FE.LG
Fragic Luvic Gleysol FR.LG
Solonetzic Luvic Gleysol SZ.LG

Luvisolic Order

Orthic Gray Brown Luvisol O.GBL
Brunisolic Gray Brown Luvisol BR.GBL
Podzolic Gray Brown Luvisol PZ.GBL
Gleyed Gray Brown Luvisol GL.GBL
Gleyed Brunisolic Gray Brown Luvisol GLBR.GBL
Gleyed Podzolic Gray Brown Luvisol GLPZ.GBL

Orthic Gray Luvisol O.GL
Dark Gray Luvisol D.GL
Brunisolic Gray Luvisol BR.GL
Podzolic Gray Luvisol PZ.GL
Solonetzic Gray Luvisol SZ.GL
Fragic Gray Luvisol FR.GL
Gleyed Gray Luvisol GL.GL
Gleyed Dark Gray Luvisol GLD.GL
Gleyed Brunisolic Gray Luvisol GLBR.GL
Gleyed Podzolic Gray Luvisol GLPZ.GL
Gleyed Solonetzic Gray Luvisol GLSZ.GL
Gleyed Fragic Gray Luvisol GLFR.GL

Organic Order

Typic Fibrisol TY.F
Mesic Fibrisol ME.F
Humic Fibrisol HU.F
Limno Fibrisol LM.F
Cumulo Fibrisol CU.F
Terric Fibrisol T.F
Terric Mesic Fibrisol TME.F
Terric Humic Fibrisol THU.F
Hydric Fibrisol HY.F

Typic Mesisol TY.M
Fibric Mesisol FI.M
Humic Mesisol HU.M
Limno Mesisol LM.M
Cumulo Mesisol CU.M

Table 2.6 Soil subgroup codes and names — *Continued*

Terric Mesisol T.M
Terric Fibric Mesisol TFI.M
Terric Humic Mesisol THU.M
Hydric Mesisol HY.M

Typic Humisol TY.H
Fibric Humisol FI.H
Mesic Humisol ME.H
Limno Humisol LM.H
Cumulo Humisol CU.H
Terric Humisol T.H
Terric Fibric Humisol TFI.H
Terric Mesic Humisol TME.H
Hydric Humisol HY.M

Hemic Folisol HE.FO
Histic Folisol HI.FO
Humic Folisol HU.FO
Lignic Folisol LI.FO

Podzolic Order

Orthic Humic Podzol O.HP
Ortstein Humic Podzol OT.HP
Placic Humic Podzol P.HP
Duric Humic Podzol DU.HP
Fragic Humic Podzol FR.HP

Orthic Ferro-Humic Podzol O.FHP
Ortstein Ferro-Humic Podzol OT.FHP
Placic Ferro-Humic Podzol P.FHP
Duric Ferro-Humic Podzol DU.FHP
Fragic Ferro-Humic Podzol FR.FHP
Luvisolic Ferro-Humic Podzol HU.FHP
Sombric Ferro-Humic Podzol SM.FHP
Gleyed Ferro-Humic Podzol GL.FHP
Gleyed Ortstein Ferro-Humic Podzol GLOT.FHP
Gleyed Sombric Ferro-Humic Podzol GLSM.FHP

Orthic Humo-Ferric Podzol O.HFP
Ortstein Humo-Ferric Podzol OT.HFP
Placic Humo-Ferric Podzol P.HFP
Duric Humo-Ferric Podzol DU.HFP
Fragic Humo-Ferric Podzol FR.HFP
Luvisolic Humo-Ferric Podzol LU.HFP
Sombric Humo-Ferric Podzol SM.HFP
Gleyed Humo-Ferric Podzol GL.HFP
Gleyed Ortstein Humo-Ferric Podzol GLOT.HFP
Gleyed Sombric Humo-Ferric Podzol GLSM.HFP

Regosolic Order

Orthic Regosol O.R
Cumulic Regosol CU.R
Gleyed Regosol GL.R
Gleyed Cumulic Regosol GLCU.R

Orthic Humic Regosol O.HR
Cumulic Humic Regosol CU.HR
Gleyed Humic Regosol GL.HR
Gleyed Cumulic Humic Regosol GLCU.HR

Solonetzic Order

Brown Solonetz B.SZ
Dark Brown Solonetz DB.SZ
Black Solonetz BL.SZ
Alkaline Solonetz A.SZ
Gleyed Brown Solonetz GLB.SZ
Gleyed Dark Brown Solonetz GLDB.SZ
Gleyed Black Solonetz GLBL.SZ

Brown Solodized Solonetz B.SS
Dark Brown Solodized Solonetz DB.SS
Black Solodized Solonetz BL.SS
Dark Gray Solodized Solonetz DG.SS
Gray Solodized Solonetz G.SS
Gleyed Brown Solodized Solonetz GLB.SS
Gleyed Dark Brown Solodized Solonetz GLDB.SS
Gleyed Black Solodized Solonetz GLBL.SS
Gleyed Dark Gray Solodized Solonetz GLDG.SS
Gleyed Gray Solodized Solonetz GLG.SS

Brown Solod B.SO
Dark Brown Solod DB.SO
Black Solod BL.SO
Dark Gray Solod DG.SO
Gray Solod G.SO
Gleyed Brown Solod GLB.SO
Gleyed Dark Brown Solod GLDB.SO
Gleyed Black Solod GLBL.SO
Gleyed Dark Gray Solod GLDG.SO
Gleyed Gray Solod GLG.SO

Phase

A soil phase is a non-taxonomic unit of soil. It is a functional unit that may be defined according to the needs of the survey. Phases of taxa at any categorical level from order to series may be defined. Two general reasons for differentiation of soil phases are:

(1) to recognize and name soil and landscape characteristics that are not criteria in soil taxonomy (e.g., slope or erosion); and

(2) to recognize and name, at a relatively high categorical level, soil properties that are differentiae at a lower categorical level. For example, depth to bedrock is a family criterion, but it can also be phase criterion at the order, great group, and subgroup levels.

Soil phases are associated with mapped areas. Some common phases and corresponding codes are listed in Table 2.7. Up to three uncoded phases may be also entered by free format. Project specific phase codes can also be developed and used.

Table 2.7 Definition of codes for common soil phases*

Code	Phase	Brief Definition			
	SLOPE:**				
01	level	— 0 — 0.5%			
02	nearly level	— 0.5 — 2.5%			
03	very gentle slopes	— 2 — 5%			
04	gentle slopes	— 6 — 9%			
05	moderate slopes	— 10 — 15%			
06	strong slopes	— 16 — 30%			
07	very strong slopes	— 31 — 45%			
08	extreme slopes	— 46 — 70%			
09	steep slopes	— 71 — 100%			
10	very steep slopes	— > 100%			
	WATER EROSION:**				
W1	slightly water-eroded	— up to 25% original A horizon eroded			
W2	moderately water-eroded	— between 25-75% original A horizon eroded			
W3	severely water-eroded	— more than 75% original A horizon eroded			
W4	gullied land	— land dissected by deep gullies			
	WIND EROSION:**				
D1	wind-eroded	— between 25-75% original A horizon eroded			
D2	severely wind-eroded	— more than 75% original A horizon eroded			
D3	blown-out land	— most of original solum eroded			
	SOIL DEPOSITION:**				
OB	overblown deposition	— significant deposit of wind-blown material			
OW	overwash deposition	— significant deposit of water-eroded material			
	STONINESS:***	% surface	distance (m) between if diameter is . . .		
	(Fragments >20 cm dia.)		25 cm	60 cm	120 cm
S1	nonstony	— <0.01	>25	>60	>120
S2	slightly stony	— 0.01-0.1	8-25	20-60	37-120
S3	moderately stony	— 0.1-3	1-8	3-20	6-37
S4	very stony	— 3-15	0.5-1	1-3	2-6
S5	exceedingly stony	— 15-50	0.1-0.5	0.2-1	0.5-2
S6	excessively stony	— >50	<0.1	<0.2	<0.5
	ROCKINESS:***				
R1	nonrocky	— <2% of surface, >100 m apart			
R2	slightly rocky	— 2-10% of surface, 35-100 m apart			
R3	moderately rocky	— >10-25% of surface, 10-35 m apart			
R4	very rocky	— >20-50% of surface, 3.5-10 m apart			
R5	exceedingly rocky	— >50-90% of surface, <3.5 m apart			
R6	excessively rocky	— >90% of surface is bedrock			
PT	PEATY	— mineral soil with 15 to 40 cm peaty material on the surface			

* Project specific phase codes can also be developed and some are already established in BCSIS.

** More complete definitions are provided in the "Canadian System of Soil Classification" (ECSS, 1987, pp. 127-129).

*** Note that the codes for stoniness and rockiness differ slightly from those in "CanSIS" (LRRI, 1983).

Family Particle Size

Soil family particle size classes are listed in Table 2.8 along with their codes. Two entries are allowed on the data form, but only if strongly contrasting size classes occur. A range of soil family particle size classes cannot be shown. Codes are entered left justified. The particle size classes are more adequately defined in Chapter 13, ECSS (1987).

Table 2.8 Soil family particle size codes

CODE	PARTICLE SIZE CLASS	CODE	PARTICLE SIZE CLASS
F	Fragmental	C	Clayey
SS	Sandy-skeletal	FC	Fine-clayey
LS	Loamy-skeletal	VFC	Very fine-clayey
CS	Clayey-skeletal	CI	Cindery
S	Sandy	A	Ashy
L	Loamy	T	Thixotropic
CL	Coarse-loamy	AS	Ashy-skeletal
FL	Fine-loamy	TS	Thixotrophic-skeletal
CSI	Coarse-silty	G	Grumic
FSI	Fine-silty		

18. PLOT REPRESENTING

This item records the actual factors for which the site was chosen as being representative. It permits a full description of the considerations made at the time of selection and allows future investigators to decide on the relevance and usefulness of the data for their own purposes. A maximum of 150 characters can be coded in free format.

19. SITE POSITION MACRO

The scale perspective for this data item is from mountain tops to main valley floors. The vertical distance is usually in excess of 300 m in most mountain regions. For areas where the landscape is dominantly a plain or plateau, circle "g" for "plain".

The terms for describing site position macro follow, with typical examples of surface shapes. Circle only one letter on the Site Description Form. Figure 2.3 illustrates the terms in an idealized sequence for mountainous terrain.

a. ***Apex*** — the uppermost portion of a mountain. Surface shape is often convex.

b. ***Face*** — a vertical rock wall with steep, exposed bedrock.

c. ***Upper Slope*** — the generally convex, upper portion of a mountain slope immediately below the apex or, if present, the face.

d. ***Middle Slope*** — the area of a mountain between the upper slope and the lower slope where the general slope profile is neither distinctly concave or convex.

e. ***Lower Slope*** — the area near the base of a mountain slope where the broad slope profile is generally concave.

f. ***Valley Floor*** — lower part of the valley system, more or less horizontal in cross section, and bounded on both sides by mountain slopes. Valley floors generally have level to moderate slopes.

g. ***Plain*** — the area in which gravitational forces and confinement of water bodies by mountainous topography (300 m difference between mountain tops and valley floors) are not major factors in the processes of landscape formation. Plateaus are considered as elevated plains (Holland 1976). Plains may occur at any elevation.

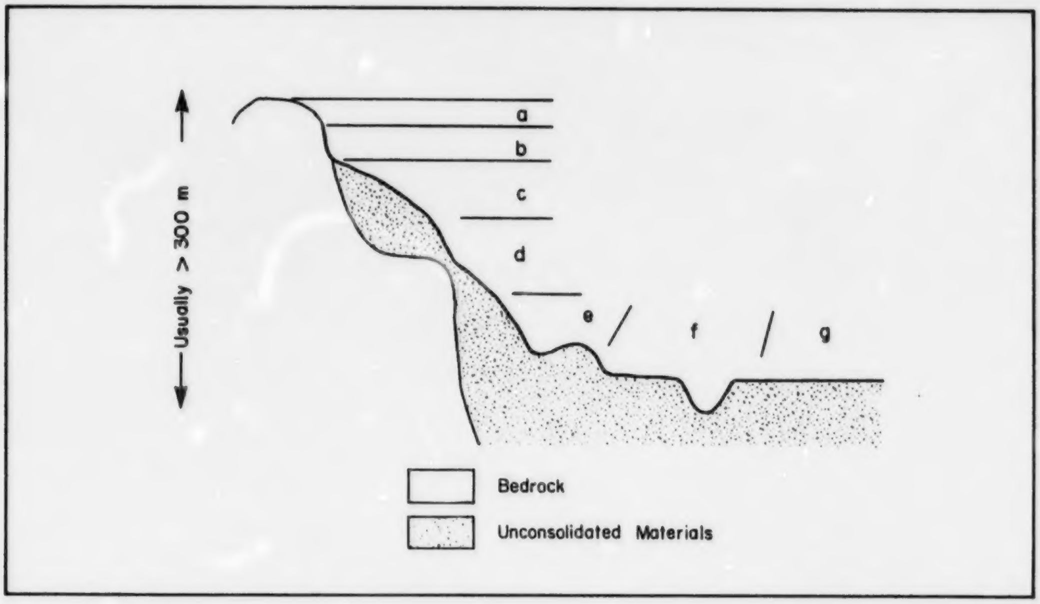

Usually > 300 m
a
b
c
d
e
f
g
Bedrock
Unconsolidated Materials

Figure 2.3 Schematic cross-sectional diagram illustrating the application of terms for describing site position macro

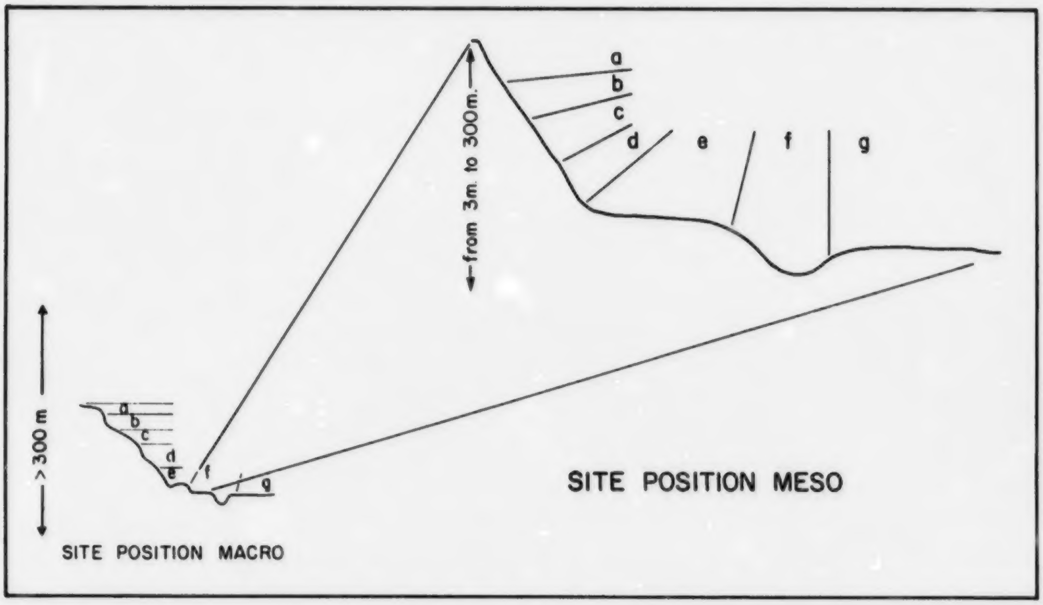

a
b
c
d
e
f
g
from 3m. to 300m.
> 300 m
a
b
c
d
e
f
g
SITE POSITION MACRO
SITE POSITION MESO

Figure 2.4 Schematic cross-sectional diagram illustrating the application of terms for describing site position meso

20. SITE POSITION MESO

Site position meso describes the relative position of the sampling site within a catchment area, which often falls within one of the major slope segments described under Site Position Macro. In some simple landscapes it may be identical to Site Position Macro. The intent is to make it consistent with the scale of topography affecting surface water flow. The vertical difference is usually between 3 and 300 m, and the surface area generally exceeds 0.5 ha in size. Figure 2.4 illustrates the relationship of Site Position Meso to Site Position Macro. Circle only one letter on the Site Description Form. Definitions of the terms follow:

a. ***Crest*** — the generally convex, uppermost portion of a hill; it is usually convex in all directions with no distinct aspect.

b. ***Upper Slope*** — the generally convex upper portion of the slope of a hill immediately below the crest. It has a convex surface profile with a specific aspect.

c. ***Middle Slope*** — the area of the slope of a hill between the upper slope and the lower slope, where the slope profile is generally neither distinctly concave or convex. It has a straight or somewhat sigmoid surface profile with a specific aspect.

d. ***Lower Slope*** — the area toward the base of the slope of a hill. It generally has a concave surface profile with a specific aspect.

e. ***Toe*** — the area demarcated from the lower slope by an abrupt decrease in slope gradient. It is often characterized by seepage.

f. ***Depression*** — any area that is concave in all directions. It is generally at the base of a meso scale slope (or toe), or in a generally level area.

g. ***Level*** — any level meso scale area not adjacent to a meso scale slope (or toe). The surface profile is generally horizontal with no significant aspect.

21. SITE SURFACE SHAPE

Site surface shape applies within each category of Site Position Meso and refers to the specific shape of the surface profile of the site or plot. The categories are described in Figure 2.5. Circle either a, b, or c (one only) on the Site Description Form.

22. MICROTOPOGRAPHY

Microtopography describes the variability in the surface configuration of a site. A site is defined as an area within a meso scale category having homogeneous vegetative cover (the cover is usually uniform, although recurring intricate mosaics may result from irregular microtopography). The magnitude of the variation is such that, within a typical sampling plot, the variability in the surface is evident. Definitions of the classes follow. Circle only one letter on the Site Description Form.

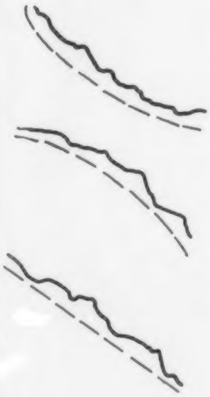
a. ***Smooth*** — few or no mounds; surface profile is linear ie., horizontal or inclined
b. ***Micromounded*** — mounds are <0.3 m high
c. ***Slightly mounded*** — mounds are 0.3 to 1 m high, and >7 m apart
d. ***Moderately mounded*** — mounds are 0.3 to 1 m high, and 3 to 7 m apart
e. ***Strongly mounded*** — mounds are 0.3 to 1 m high, and 1 to 3 m apart
f. ***Severely mounded*** — mounds are 0.3 to 1 m high, and 0.3 to 1 m apart
g. ***Extremely mounded*** — mounds are >1 m high, and >3 m apart
h. ***Ultramounded*** — mounds are >1 m high, and <3 m apart

23. MESO SLOPE LENGTH

Meso slope length is the estimated or measured distance (in metres) between the upper and lower extremities of the Site Position Meso associated with the site. It is the total length of the slope defining the catchment area in which subsurface water is transmitted through the landscape. If the slope length is not determined in the field, it can be estimated from appropriate topographic maps, or aerial photographs. Figure 2.6 illustrates the application of meso slope length. Lengths in metres are entered right justified on the Site Description Form.

24. MESO UPSLOPE LENGTH

Meso upslope length is the maximum upward length of the slope above the sampling site, which directly acts as a catchment area for moisture supply to the site. If the upslope length is not determined in the field, it can be estimated from appropriate topographic maps, or aerial photographs. Figure 2.7 illustrates the application of meso upslope length. Lengths in metres are entered right justified on the Site Description Form.



concave - the surface profile is predominantly "hollow" in one or several directions.

convex - the surface profile is predominantly "rounded" like the exterior of a sphere or circle.

straight - the surface profile is linear, either flat or sloping in one direction.

Figure 2.5 Illustration of site surface shape

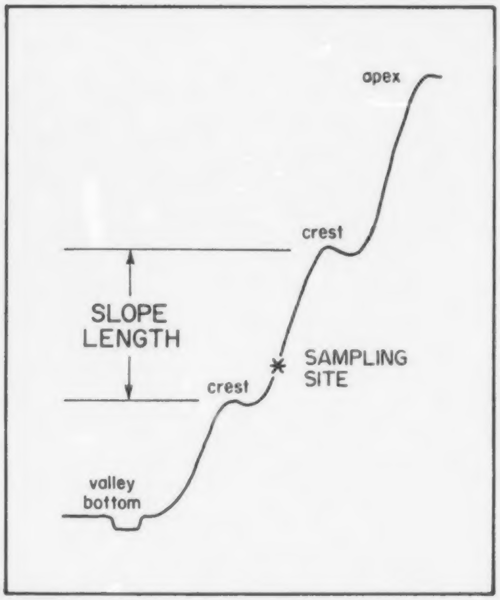

apex
crest
SLOPE LENGTH
SAMPLING SITE
crest
valley bottom

Figure 2.6 Schematic illustration of meso slope length

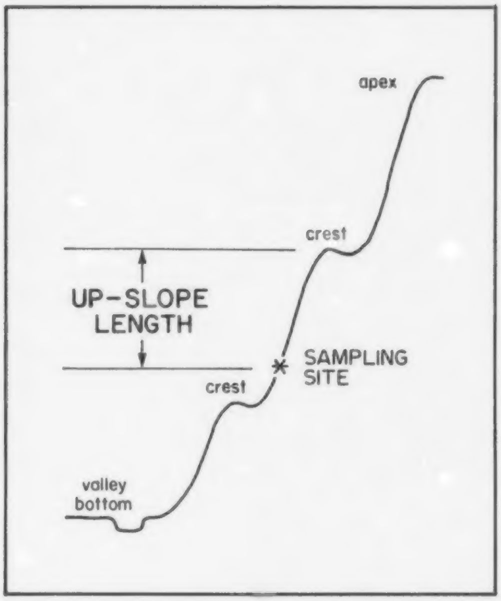

apex
crest
UP-SLOPE LENGTH
SAMPLING SITE
crest
valley bottom

Figure 2.7 Schematic illustration of meso upslope length

25. SITE POSITION DIAGRAM

The site position diagram provides an opportunity to include a free-hand sketch of the landform or landscape within which the sampling site is located. Its intent is to provide a three-dimensional, cross-sectional, and/or aerial view sketch that will aid in:

- locating the current site with respect to the location of other sites;
- depicting the physical features of the surrounding landscape such as landforms and rivers;
- communicating why this particular site was chosen; and
- relocating the site by pointing out identifiable landmarks.

Scale and compass direction must be recorded in the appropriate spaces. Any photographs taken of the site can be identified by roll and photo number. To facilitate identification, the form number and/or plot number should be placed on the slides or on the back of prints. Figure 2.8 provides an example a site position diagram. If a diagram drawn for another data form includes the site being described on this form, enter the form number in the appropriate space.

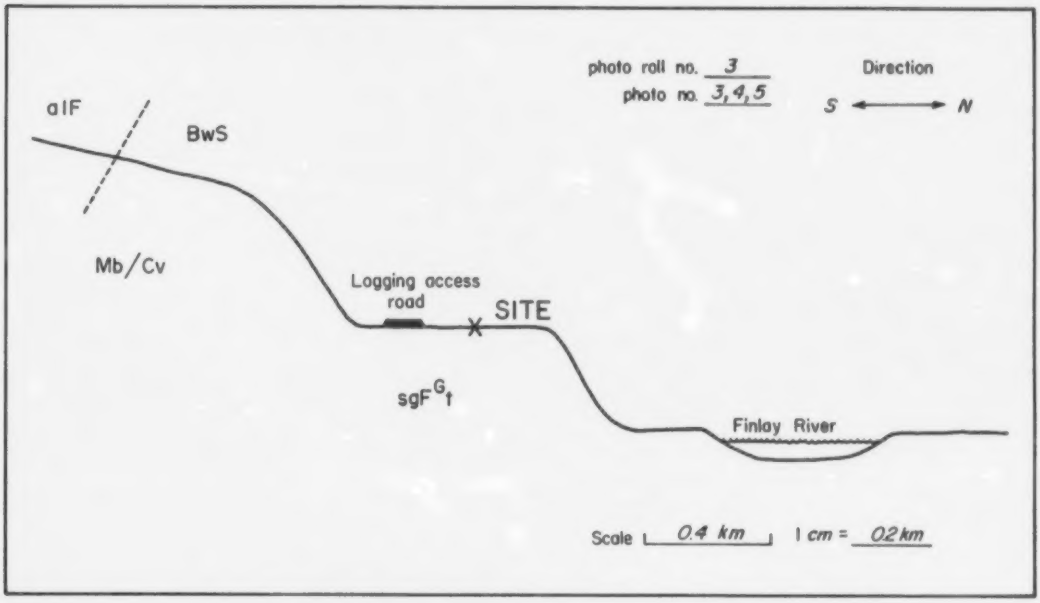


Figure 2.8 Example of a site position diagram

26. EXPOSURE TYPE

Exposure type refers to atmospheric and other climate related conditions at the site which deviate from the typical (normal) climate. These deviating conditions are considered significant if they are reflected in the soils and/or vegetation.

The descriptions of the following exposure types are relative to the typical climatic conditions of an area. The soil and vegetation characteristics given are examples only, and should not be considered to be definitive. Circle up to three codes, a through g. In addition, "other" and "comments" may be completed as free format items.

a. ***Not Applicable*** — this category applies to all areas where significant exposure to deviating climate-related conditions is not evident in soils or vegetation.

b. ***Wind*** — this category is applicable where a site is directly influenced by strong winds. This may occur on exposed mountain tops, along seashores or large lakes, or in areas where "wind funnelling" occurs because of the convergence of valleys in the direction of wind flow. Soil indicators include weak soil profile development due to scalped (eroded) profiles, evidence of soil erosion on windward side and deposition on leeside, and duning. Vegetation indicators include strongly reduced height growth and gnarled growth form with tree tops and branches oriented downwind, and wind-shorn thickets of trees or shrubs (wind-shorn surface of vegetation follows the outline of any object providing wind protection).

c. ***Insolation*** — this category is applied to sites directly subjected to radiant solar heating to a degree significantly greater than that on associated flat-lying ground. It generally occurs on SE, S, and SW aspects with slopes between 20% and 50%. Soil indicators include weak soil profile development reflecting a drier environment (compared to normal profiles for the area), and sometimes, profiles with darker colored surface horizons. Vegetation indicators include the presence of heat-tolerant species, reduced tree growth, slow or sparse tree regeneration, open crown cover, and tree regeneration in distinct age groups reflecting "wetter" years.

d. ***Frost*** — this category refers to cold air accumulation in depressions and valley bottoms during conditions of high night-time surface cooling and/or cold air drainage. Frost pockets are often surrounded by slopes leading to higher elevations, from which the cold air originates. Soil indicators include wet and/or organic conditions in depressional locations. Vegetation indicators include the presence of species which are normally found in conditions colder than those of the general area, such as subalpine fir in the Interior Douglas-fir Zone; the presence of frost-hardy shrubs and herbs (such as scrub birch, marsh cinquefoil, and/or shrubby cinquefoil); and an abundance of frost cracks on the trunks of trees.

e. ***Cold Air Drainage*** — this category is applied to areas such as mountain gullies, through which cold air passes. Although these areas often grade into frost pockets, they are distinct from the latter in that no accumulation of cold air occurs. Soil and vegetation indicators are similar to those in "d", but the influence of cold temperatures is usually not as pronounced.

f. ***Saltspray*** — this category is applied to areas that receive saltspray from a marine environment to the extent that the type and growth form of the vegetation, as well as the chemical and morphological characteristics of the soil, are affected. Soil indicators include high pH and conductivity, presence of white salt accumulations as distinct crystals, and weak profile development. Vegetation indicators include an abundance of salt-tolerant species, and slow growth of many species.

g. ***Atmospheric Toxicity*** — this category is applied to areas where, for example, highly acid or alkaline precipitation, or chemically toxic fumes from industrial plants, affect the type and growth form of the vegetation, as well as the chemical and morphological characteristics of the soil. Soil characteristics include unexpected very high or very low pH values, and accumulations of chemicals which are normally either absent or only present in small quantities. Vegetation indicators include defoliated areas, the presence of diseased or dead standing species, and an abundance of species tolerant to abnormal chemical accumulations.

Other — this category is used to identify other forms of exposure such as localized rainshadow, snow accumulation, tidal exposure (intertidal area), and fresh water spray (near waterfalls and rapids). A maximum of 20 characters can be coded in free format.

Comments — a brief explanation to justify the coded categories can be recorded here. A maximum of 50 characters can be coded in free format.

27. ECOLOGICAL MOISTURE REGIME (adapted from Klinka, 1977, and Utzig *et al.*, 1978)

Ecological moisture regime (hygrotope), relative to certain macroclimatic conditions represented by a biogeoclimatic subzone or any other bioclimatic unit, signifies on a relative scale the available moisture supply for plant growth. At present, there has been little quantitative investigation of the classes described here.

Klinka *et al.* (1984) have initiated quantification of moisture regime and contains further information on the classes of the actual hygrotopes and their determination. The "relative" moisture regime discussed here refers to the potential hygrotope as it relates to the capacity of a soil to hold, lose, or receive water. It is determined from the soils' properties and position in the landscape, regardless of climate. The term 'actual hygrotope' should only be used when the actual capacity of a soil to supply water for plant growth is determined.

Table 2.9 Ecological moisture regime classes and codes

Moisture Regime and Codes	Defining Characteristics		Field Recognition Characteristics						Slope Gradient
				Soil Properties					
	Description	Primary Water Source	Slope Position Meso	Texture	Drainage	Depth to Impermeable Layer	Surface Humus Depth	Available Water Stor. Cap.	
Very Xeric 0	Water removed extremely rapidly in relation to supply, soil is moist for a negligible time after ppt.	precipitation	ridge crests, shedding	very coarse (gs), abundant coarse fragments	very rapid	very shallow (<0.5 m)	very shallow	extremely low	very steep
Xeric 1	Water removed very rapidly in relation to supply; soil is moist for brief periods following ppt.	precipitation			rapid				
Subxeric 2	Water removed rapidly in relation to supply; soil is moist for short periods following ppt.	precipitation	upper slopes, shedding	coarse to moderately coarse (ls-sl), moderate coarse fragments	rapid to well	shallow (<1 m)	shallow	very low	steep
Submesic 3	Water removed readily in relation to supply; water available for moderately short periods following ppt.	precipitation						low	
Mesic 4	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflect climatic inputs.	precipitation in moderately to fine-textured soils and limited seepage in coarse textured soils	mid-slope, normal, rolling to level	medium to fine (l-sil), few coarse fragments	well to moderately well	moderately deep (1-2 m)	moderately deep	moderate	moderate
Subhygric 5	Water removed slowly enough to keep the soil wet for a significant part of the growing season; some temporary seepage and possibly mottling below 20 cm.	precipitation and seepage	lower slopes, receiving	variable, depending on seepage	moderately well to imperfect	deep (>2 m)	deep	high	slight
Hygric 6	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling, perhaps weak gleying.	seepage			imperfect to poor	variable, depending on seepage		variable, depending on seepage	
Subhygric 7	Water removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral or organic soils; permanent seepage less than 30 cm below the surface.	seepage or permanent water table	depressions, receiving	variable, depending on seepage	poor to very poor		very deep		
Hydric 8	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral or organic soils.	permanent water table			very poor	variable, depending on seepage		variable, depending on seepage	flat

Potential hygrotope assumes that within a given subzone, climatic variables such as temperature and precipitation are essentially constant (or vary within narrow ranges). Therefore, the within-subzone variation of available moisture must result from the redistribution of precipitation by edaphic factors. Mesic sites have an amount of available moisture that reflects regional climate and usually are areas with moderate slopes, middle meso-slope locations, and medium textures. Those areas with less than normal available moisture grade to xeric, and those with more than normal available moisture grade to hydric (see Table 2.9).

The ecological moisture regime is a relative ranking of sites based on their available moisture supplies (available moisture is that which is held between 1/3 bar and 15 bars matric potential). Because available moisture is a dynamic property varying throughout the year, the intent of the assessment is to evaluate available moisture on the basis of the growing season as a whole for a period of years, and not at any particular time.

The ecological moisture regime integrates many interrelated environmental and biotic parameters which, in combination, determine the actual amount of available moisture. Thus, the field assessment is ideally completed through an evaluation of a combination of environmental factors, soil properties, and indicator plants, although it can be made on the basis of plant indicators or environmental factors and soil properties alone. A schematic illustration of the influence of some of these factors is given in Figure 2.9. The ecological moisture regime classes and associated identifying characteristics are given in Table 2.9.

Ecological moisture regime is correlated with the following factors: micro-variations in topoclimate, slope position (meso relief), slope gradient, soil drainage, depth of surface humus layers, soil texture (including the content of coarse fragments), soil depth, and the presence of impermeable layers. Factors related to internal soil properties can be evaluated in soil pits or road cuts. In general, the most influential factor is the position on the slope. On ridges and upper slopes, precipitation is the main source of water since moisture generally passes quickly downslope and little, if any, moisture is retained. Middle slopes receive, in addition to precipitation, some seepage from upslope, but this seepage flow moves further downslope and usually dissipates during the summer. The lower slopes, flats, and depressions are usually enriched by a temporary or permanent seepage waterflow. The amount of available moisture often increases with decreasing slope gradient, decreasing soil particle size (i.e., from coarse to fine textured soils), decreasing content of coarse fragments, increasing soil depth, and increasing thickness of humus layers (in particular, with the thickness of colloidal and humified H-layer). The presence of an impermeable layer (e.g., bedrock, compacted till, cemented layer) may inhibit soil water storage, or create conditions for temporary or permanent seepage if subsurface water flow seepage is present.

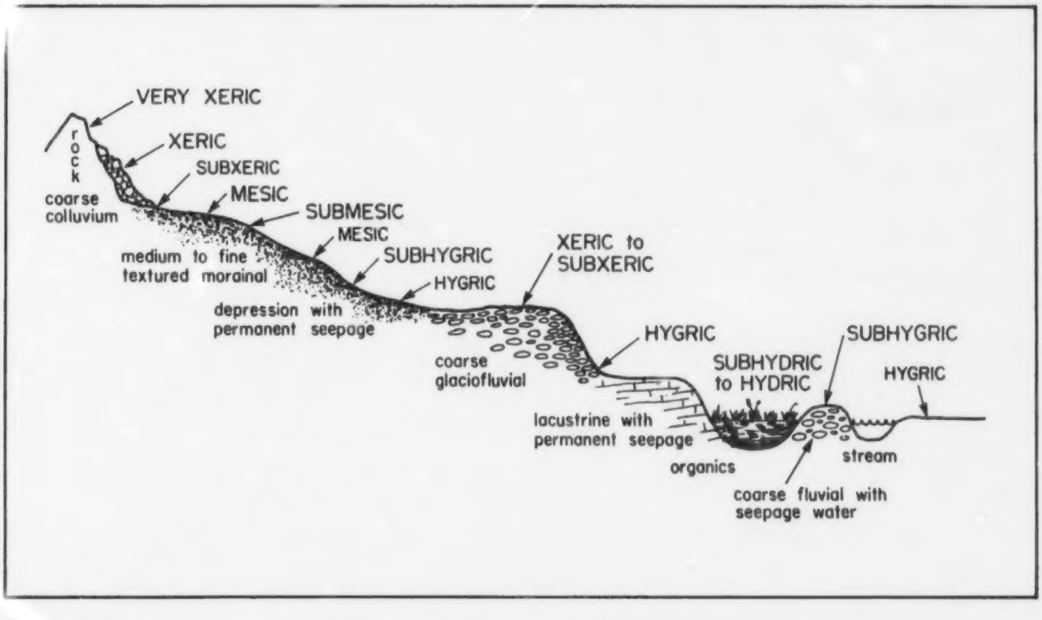


Figure 2.9 Generalized ecological moisture regime in relation to landscape position and geologic material

The use of plant indicators for assessing ecological moisture regime requires an existing vegetation classification scheme for the subzone under consideration or a reconnaissance of the area, sufficient for the surveyor to establish relationships between plant indicators and the range of edaphic conditions. When sites near subzone boundaries are assessed, care must be taken to differentiate between seepage inputs, and increases in precipitation, or decreases in evapotranspiration demands. For example, plants normally found on mesic sites in one subzone can occur on subhygric sites in an adjacent subzone with lower precipitation or higher temperatures. Care must also be taken to assess the plant community as a whole. Some species may have a limited rooting depth and do not reflect the presence of deep seepage waters, while other species may reflect changes in nutrient availability rather than available moisture. Even when extensive vegetation information is available, it is always best to consider the environmental factors as well.

28. NUTRIENT REGIME (adapted from Utzig *et al.*, 1978, and Klinka *et al.*, 1984)

Soil nutrient regime (trophotope) indicates on a relative scale the available nutrient supply for plant growth (with emphasis on soil pH and the exchangeable cations Ca, Mg, Na, and K). The soil's nutrient regime integrates many environmental and biotic parameters which, in combination, determine the actual amounts of available nutrients. It is a dynamic property, characterized by inputs and losses, with seasonal variations. The aim of the assessment is to derive an estimate of the available nutrient supply for a site, which will characterize it relative to all other sites occurring within the respective biogeoclimatic subzone or other bioclimatic unit.

At present, the assessment of soil nutrient regimes is qualitative for a number of reasons, including a lack of understanding of the role played by soil weathering and forest humus layers in the supply of nutrients, and a lack of information on the required nutrient levels for optimum growth of various species (particularly trees). In general, however, biomass production is expected to increase from oligotrophic to eutrophic nutrient regimes for a given hygrotope, depending somewhat on particular climatic conditions (e.g., biogeoclimatic subzone) and species. Exceptions may occur with nutrients such as phosphorus, which is often unavailable (and limiting) at high pH; nitrogen, which occurs in various forms and can be limiting to the growth of some species; or sulfur, which may be present in only minute amounts in some soils. Eutrophic and hypereutrophic nutrient regimes may contain excess salts, which limit the uptake of water by most plant species.

Table 2.10 summarizes information for assessing soil parent materials, humus layer, seepage water, and analytical data when determining soil nutrient regime. Some of the main factors are more fully discussed in the following paragraphs.

Soil Mineralogy (Bedrock Source)

The kind of bedrock from which the soil parent materials are derived can be a useful guide in assessing nutrient regime. Identification of rock fragments in the soil is preferable, although local outcrops or information from geologic maps may be used. During the last major glaciation, glacial materials were derived mainly from local bedrock sources, producing soil parent materials that often reflect local bedrock characteristics. This is particularly true in small valley systems where the bedrock is uniform and surficial materials have moved only short distances. Larger valleys are more likely to contain soil parent materials derived from varying bedrock sources. Wherever bedrock is used as the primary differentiating criterion, the rock types occurring as coarse fragments should be compared with those indicated on geologic maps or in adjacent outcrops.

Soils derived from basic igneous rock (e.g., basalt, gabbro), basic metamorphic rock (e.g., argillite, biotite schist, gabbro gneiss), and basic sedimentary rock (e.g., limestone, dolomite) are generally mesotrophic to eutrophic because of the abundance of basic elements found in the minerals of these rocks. These rock types also generally result in finer textured soil materials than the more resistant, acidic bedrock types. Soils derived from acid igneous rocks (e.g., rhyolite, granite, quartz monzonite), acid metamorphic rock, (e.g., granite gneiss, quartzite), and some sedimentary rock (e.g., conglomerate) are usually oligotrophic to mesotrophic.

Soil Texture and Coarse Fragments

Soil texture, as it affects cation exchange capacity, may also be used to assist in the assessment of soil nutrient regime. Landform and terrain characteristics may be used in a general way, since they often infer soil texture and coarse fragements (e.g., glaciofluvial sediments are usually coarse-textured and nutrient poor). The capacity of a mineral soil to retain nutrients (and water) depends largely on the amount of clay. Coarse-textured surficial materials (usually glaciofluvial, fluvial, colluvial, and some morainal deposits) generally have low cation exchange capacities, and tend to fall into the oligotrophic to mesotrophic nutrient regimes. Finer textured materials (lacustrine and some morainal, fluvial, and colluvial deposits) have higher cation exchange capacities, and generally relate better to the mesotrophic to eutrophic nutrient regimes. Texture relationships, however, must always be considered in relation to the mineralogy (or bedrock source) of the parent materials, and the presence or absence of seepage water and incorporated organic matter.

Table 2.10 Nutrient regime characteristics and codes*

	Oligotrophic A	**Submesotrophic** B	**Mesotrophic** C	**Permesotrophic** D	**Eutrophic** E	**Hypereutrophic** F
Definition	very poor nutritional status, very small supply of available nutrients	poor nutritional status, low supply of available nutrients	medium nutritional status, medium supply of available nutrients	rich nutritional status, plentiful supply of available nutrients	very rich nutritional status, abundant supply of nutrients	saline nutritional status, excess salt accumulations
Bedrock Source	granite	granodiorite	diorite	gabbro	peridotite dunite	serpentine
	rhyolite	dacite	andesite	basalt		
	quartzite	quartz gneiss	garnet schist	biotite schist	slate	phyllite-marble
	quartz sandstone	conglomerate	graywacke	argillite-shale-dolomite-limestone-gypsum-halite		
Texture	very coarse	coarse	medium	fine	very fine	variable
Coarse Fragment Content	high		moderate to low		variable	
Soil Porosity	low	medium to high				
Organic Matter Content	low	moderate		high	variable	
Humus Form	acid mors	mors and moders		moders and mulls		
Soil Depth	extremely shallow		very shallow to deep		variable	
Soil Reaction	extremely to medium acid	medium acid to neutral		slightly acid to mildly alkaline		moderately to strongly alkaline
Cation Exchange Capacity	low	moderate		high	variable	
Base Saturation	low	moderate		high	variable	
C/N Ratio	high	moderate		low	variable	

* Nutrient-rich seepage water may compensate for other factors to create eutrophic conditions.

Humus Form

The humus form refers to the group of horizons located at the soil surface which have formed primarily from organic materials, and which may include mineral soil intermixed with organic material. The quality of the humus form is an expression of the degree of decomposition and mineralization of soil organic materials. As a result, humus forms can be used as indicators of the intensity of biological nutrient cycling. The decomposition rate is influenced by the physical and chemical properties, temperature, and moisture conditions of the forest floor, which, in turn, determine the kinds and numbers of soil flora and fauna present. Thus, the quality of the humus form can be used for making inferences about the factors controlling decomposition or the results of decomposition, such as acidity, content of bases, and aeration in the uppermost soil layer or the amount of readily available nutrients, particulary nitrogen.

The rate at which organic materials decompose results in one of three basic humus form classes: Mor, Moder, or Mull. In Mors, decomposition is slow, resulting in accumulation of organic materials on the forest floor and relatively low amounts of available nutrients. Thus "Mor" sites tend to be oligotrophic to mesotrophic. The low availability of nutrients, however, can be partially compensated by the effects of mycorrhizae, which increase the capacity of infected plants to absorb water and nutrients. In Mulls, decomposition is rapid resulting in a very thin forest floor and high amounts of easily available nutrients. Thus, "Mull" sites tend to be permesotrophic to eutrophic. Moders are intermediate in these characteristics. More detailed information on description and classification of humus forms is given in Item 42, and Chapter Seven.

Soil Organic Matter Content

Soil organic matter originates either from above-ground vegetation or in-ground roots and organisms. These organic remains undergo humification yielding dark coloured, amorphous "humus" as a final product. Humus may become incorporated into the mineral soil by the action of organisms, by infiltration, or as the residue of root systems.

Upon incorporation with mineral soil, organic matter greatly improves both soil water-and-nutrient-holding capacities, and soil porosity. Also, organic matter is a major source of phosphorus and sulphur, and essentially the sole source of nitrogen. Thus, the amount of organic matter present can generally be an indicator of reserves of these elements in the soil, particularly of nitrogen, but not necessarily of their availability. Lastly, organic matter is the main source of energy for soil microorganisms. Soils low in organic matter (light coloured) can be expected to be drier and more nutrient poor than those that contain high amounts and are usually dark coloured.

Soil Porosity and Aeration

Soil pores normally contain both air and water, but the relative proportions of each are constantly changing. The percentage of pores occupied by air is referred to as soil aeration. Soil aeration depends on the exchange of air in the soil with atmospheric air, assuming that there is a potential for the ready movement of gases into and out of the pore spaces. In general, soil aeration affects absorption of water, oxygen, and nutrients by plant roots. Soil air is important primarily as a source of oxygen to aerobic organisms, particularly for tree roots and soil microorganisms. Good aeration favours root development and penetration, and results in more intense exploitation of the soil for water and nutrients. It also favours microorganism activity which, in turn, may increase the supply of available nutrients.

Soil porosity and aeration is evaluated from a combination of the following soil properties: observable pores, colour, structure, and bulk density. Large diameter pores, such as old root channels, are visually estimated. In wet climates, reddish colours due to ferric (oxidized) compounds are associated with well-aerated soil, while yellowish colours signify intermediate aeration. Ferrous (reduced) compounds of blue and olive colours indicate poorly-aerated soils, while mottling usually indicates a zone of seasonally good and poor aeration. Soil structure, to a great extent, determines the bulk density (mass of soil per unit volume) of a soil. As a rule, soils with high bulk density are more compact, have poorly defined structure, and lower amounts of pore space. See Horizon Porosity (Chapter Three, Item 17) for definitions of porosity classes.

Soil Depth

Soil depth refers to the effective depth of the soil that is suitable for occupation by roots. It varies from a few centimetres to several metres, with the lower limit often being sharply delineated by some restricting layer such as bedrock, compacted (basal) till, or cemented soil horizons. Effective rooting depth can also be restricted by low soil temperature, poor soil aeration and permanent water tables. The volume of soil available to roots affects the water and nutrient storage capacity of the soil. Thus, shallow soils are generally drier and more nutrient-poor than deep soils.

Groundwater and Incidence of Flooding

Groundwater adds water to the soil which is additional to that from precipitation. It has a direct influence on moisture regime; however, its influence on nutrient regime depends on whether the groundwater is stagnant or moving. Stagnant groundwater usually has an adverse influence on plant nutrient availability and uptake. It reduces the effective rooting depth, limits the oxygen supply for roots and aerobic microorganisms, and increases the specific heat of the soil (the soil tends to be colder than surrounding non-saturated soils). In contrast, laterally moving groundwater (seepage and flood-waters) often has a favourable influence on nutrient content, availability, and uptake, usually to the extent of overriding the influence of several other properties related to trophotope. Because the moving groundwater carries solutes and suspended materials, it represents either a temporary or constant additional input of nutrients such as nitrogen, sulphur, calcium, and magnesium. As a result, soils affected by stagnant groundwater are likely oligotrophic to mesotrophic, while those affected by moving groundwater are likely mesotrophic to eutrophic.

The influence of periodic flooding on nutrient regime depends on the frequency and intensity of flooding and the proximity of the site to the stream. Where floodwater movement is slow, as on downstream floodplains, deposits of rich, fine organic and mineral materials are common and sites are likely to be permesotrophic to eutrophic. In contrast, where floodwater movement is rapid, such as that on upstream terraces, deposits are generally poor, mainly coarse mineral materials that are generally submesotrophic to mesotrophic.

Soil Analytical Data

One of the most easily measured chemical soil characteristic is pH. Within the range of soil pH (with emphasis on soil B horizons), sites with lower pH's (e.g., 4.0) tend to be oligotrophic and those with higher values (e.g., 7.0) tend to be eutrophic. In addition to pH, measured values of base saturation and cation exchange capacity are also useful criteria. With increasing base saturation and cation exchange capacity, the nutrient regime ranges from oligotrophic to eutrophic. Quantitative characterization of nutrient regimes is difficult even when calculations of nutrients (in kg/ha) are made, since not all the nutrients are available for plant uptake. For forestry, Ballard and Carter (1986) suggest growth and foliage analysis give a better measure of nutrient status.

In attempting to classify soil nutrient regimes, Klinka *et al.*, (1984) considered those soil chemical properties that could provide an index of the supply of essential nutrients for plant growth. Other considerations included analytical feasibility and estimation from morphological properties of the soil. The four properties chosen were: acidity (pH); carbon:nitrogen ratio (C/N) of the humus form; total soil nitrogen; and the sum of exchangeable calcium, magnesium, and potassium measured in kg/ha to rooting depth. Nitrogen is one of the elements needed in the largest quantities by plants and one generally found to be most influential in increasing plant growth.

29. SOIL TEMPERATURE CLASS
and
30. SOIL MOISTURE SUBCLASS

Soil family and series descriptions should include identification of soil temperature classes (STC) and soil moisture subclasses (SMS). Each STC and SMS is defined by specific climatological criteria (see Expert Committee on Soil Survey, 1987, Tables 3 to 5, pp. 121-123). Soil temperature classes are based mainly on mean annual soil temperature, the length of the growing season, and accumulated degree-days.

Soil moisture subclasses are defined for both saturated and unsaturated soils. Aquic regimes are differentiated by the length of time the soil is saturated during the growing season. Unsaturated regimes are differentiated by the severity of water deficits during the growing season.

The "Soil Climates of Canada" map (Clayton *et al.*, 1977), can provide some assistance in determining the STC and SMS that will likely occur within a particular project area. However, rather than relying solely upon the map designations for a given area, sites should be individually assessed on the basis of local climate and microclimatic variations. Extrapolation from local meteorological station data should assist in assessing the influence of site variations such as differences in elevation, slope and aspect, on STC and SMS.

Useful estimates of mean summer soil temperature can be obtained by averaging the three mid-monthly readings of soil temperature at 50 cm depth, taken in July, August, and September. Mean annual soil temperature in many areas can be estimated by adding 1°C to the mean annual air temperature (U.S.D.A., 1975). Another useful guide for STC estimation is Agriculture Canada's (1975) "Estimated Monthly Normals of Soil Temperature in Canada".

Tables 2.11 and 2.12 indicate the differentiating characteristics of soil temperature classes and soil moisture subclasses. Circle one entry each for STC and SMS on the Site Description Form. Note that actual soil temperature measurements and soil moisture conditions can be recorded on the Soil Description Form as explained in Chapter Three.

The suggested steps for assessing STC and SMS are:

1. Consult Ministry of Environment climatologists to determine availability of climate data for STC and SMS assessments.
2. If data exist, assess STC and SMS for modal soils (e.g., deep, medium textured) at various locations in the project area, taking into consideration elevation, slope, and aspect. Then determine the sensitivity of changes in soil conditions (e.g., depth to bedrock) to class limits. Where seepage or groundwater provides additional soil moisture to a site, subjectively decide how this affects STC and SMS. Eventually, as relationships are determined with the aid of a climatologist, relating STS and SMS to natural vegetation will probably prove useful in extrapolating site data to other areas.
3. If data is inadequate, you may decide not to assess STC or SMS at all. However, if an attempt is made, consult the "Soil Climates of Canada" map (Clayton *et al.*, 1977) to determine regional soil climate characteristics of the modal soils in the area, and adjust them according to soil and vegetation conditions for drier or wetter sites.

Table 2.11 Soil temperature class characteristics

Soil Temperature Classes and Codes	Description	MAST*	MSST**	Growing Season (Days >5°C)	Degree-Days (>5°C)	Warm Thermal Period (Days >15°C)	Degree-Days (>15°C)
EXTREMELY COLD a	Continuous permafrost usually occurs within 1m of the surface	< −7°C	<5°C	<15	0	0	0
VERY COLD b	Soils frozen during the dormant season; discontinuous permafrost may occur	−7 to 2°C	5 to 8°C	<120	<550	0	0
COLD c	Soils usually frozen in some part of the control section in part of the growing season, no permafrost	2 to 8°C	8 to 15°C	140-220	550-1250	0-50	<30
COOL d	Soils may or may not be frozen in part of the control section for a short part of the dormant season	5 to 8°C	15 to 18°C	170-220	1250-1700	>60	30-220
MILD e	Soils are rarely frozen during the dormant season	8 to 15°C	15 to 22°C	200-365	1700-2800	90-180	170-670

* MAST: mean annual soil temperature at 50 cm depth.
** MSST: mean summer soil temperature at 50 cm depth.

Table 2.12 Soil moisture subclass characteristics

		Differentiating Characteristics		Suggested Criteria for Organic Soils	
Soil Moisture Subclasses and Codes	**Description**	**Water Deficits**	**CMI***	**Saturation Period (mo)**	**Moist Period (mo)**
Peraquic j	Soil saturated for very long periods	—	—	>10	<2
Aquic i	Soil saturated for moderately long periods	—	—	4-10	2-8
Subaquic h	Soil saturated for short periods	—	—	<4	8-11.5
Perhumid g	No significant water deficits in growing season	< 2.5 cm	>84	<2	8-11.5
Humid f	Very slight deficits in growing season	2.5-6.5 cm	74-84	<0.5	8-11.5
Subhumid e	Significant deficits in growing season	6.5-13 cm	59-73	—	—
Semiarid d	Moderately severe deficits in growing season	13-19 cm	46-58	—	—
Subarid c	Severe deficits in growing season	19-38 cm (cool) 19-51 cm (mild)	25-45	—	—
Arid b	Very severe deficits in growing season	>38 cm (cool) >51 cm (mild)	<25	—	—
Xeric a	Soil dry in all parts 45 consecutive days or more between July and October for more than 6 years out of 10.				

* $\text{CMI} = \frac{P}{P + SM + IR} \times 100$ Where: CMI = Climatic Moisture Index

P = growing season precipitation

SM = water available to plants that is stored in soil at the beginning of the growing season

IR = water deficit for the growing season or irrigation requirements for crops

31. SOIL DRAINAGE

Soil drainage refers to the rapidity and extent of water removal from the soil in relation to additions, especially by surface runoff and by percolation downwards through soil. Although permeability, groundwater level, and seepage are factors affecting moisture status, they are not usually easily observed or measured in the field, and they cannot be generally used as criteria for drainage classes. Soil water regime classification provides a more detailed assessment of soil water conditions and is discussed in Chapter Three.

Soil profile morphology (for example, mottling) normally, but not always, reflects soil drainage. Although soil morphology may be a valuable field indication of drainage class, it should not be the overriding criterion. For example, a soil may exhibit the morphology of a poorly drained soil, but recent changes (either natural or artificial) may result in the soil being imperfectly drained. Some soils that are considered to be imperfectly drained lack mottling because of the nature of the minerals within them. Therefore, soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation, as well as other soil characteristics, are useful field criteria for assessing soil drainage classes.

The definitions of the soil drainage classes (Land Resource Research Institute, 1983) are provided below. Circle only one class on the Site Description Form.

a. ***Rapidly drained*** — water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (less than 4 cm) within the control section, and are usually coarse textured, or shallow, or both. The water source is precipitation. The very rapidly drained class in L.R.R.I. (1983) is included here.

b. ***Well drained*** — water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes, subsurface flow may occur for short durations, but additions are equalled by losses.

c. ***Moderately well drained*** — water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly because of low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6 cm) within the control section and are usually medium to fine textured. Precipitation is the dominant water source in medium to fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse textured soils.

d. ***Imperfectly drained*** — water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major supply. If subsurface water or groundwater (or both) is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface or groundwater flow (or both) increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are usually gleyed subgroups of usually well drained soil orders.

e. ***Poorly drained*** — water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface or groundwater flow (or both) in addition to precipitation, are the main water sources. A perched water table may be present. The soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups of usually well drained soil orders, or fall within the Gleysolic or Organic orders.

f. ***Very poorly drained*** — water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are the major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

32. PERVIOUSNESS

Soil perviousness classes are intended to eliminate confusion between soil drainage and permeability. Soil perviousness refers to the ability of a soil to transmit water internally, and is inferred from soil characteristics such as structure, texture, porosity, cracks, organic matter content, and shrink-swell properties. Perviousness is closely related to permeability, percolation rate, and infiltration rate, but these are usually determined by actual measurements that use standard techniques. Perviousness applies to the *whole soil profile* and the perviousness class is determined by the *least permeable layer* in the soil "control section" (CSSC, 1978, p. 22). It is important to distinguish between soil drainage and perviousness. For example, a rapidly pervious soil may be receiving excessive seepage and thus be poorly drained. Circle only one code on the Site Description Form.

a. ***Rapidly pervious*** — the capacity to transmit water vertically is so great that the soil will remain wet for no more than a few hours after thorough wetting. The horizons and soils have large and continuous or connecting pores and cracks that do not close with wetting.

b. ***Moderately pervious*** — the capacity to transmit water vertically is great enough that the soil will remain saturated for no more than a few days after thorough saturation. Most moderately pervious soils hold relatively large amounts of water against the force of gravity, and are considered good, physically, for rooting and supplying water to plants. Soil horizons may be granular, blocky, weakly platy or massive (but porous) if continuous conducting pores or cracks are present which do not close with wetting.

c. ***Slowly pervious*** — the potential to transmit water vertically is so slow that the horizon or the soil will remain saturated for periods of a week or more after thorough wetting. The soil may be massive, blocky, or platy, but connecting pores (which conduct water when the soil is wet) are few, and cracks or spaces between peds (which may be present when the soil is dry) close with wetting. Even in positions accessible to plant roots, the soil usually has few or no roots. When present, roots are localized along cracks.

33. FREE WATER

The presence of free water in a soil pit following excavation is usually the result of seepage or high water tables. Areas with free-standing water on the surface are also included in this category. Free water is recorded by circling either "a" for present or "b" for absent. Depth to water table, if present, is recorded in Item 35.

34. FLOOD HAZARD

Biophysical approaches to flood hazard assessment are based on the integration of information from a variety of disciplines including surficial geology, fluvial geomorpholgy, pedology and botany. In undeveloped or relatively undisturbed areas, these biophysical characteristics can be used to assess flood hazard without the necessity of undertaking detailed hydrological or hydraulic analyses. Comparative studies indicate that biophysical techniques compare favourably with those developed using standard engineering procedures (e.g., Parker *et al.*, 1970 and Reckendorf, 1973). It should be noted that flood hazard refers here to overflow by rivers, creeks and streams, and not to periodically high ground water tables.

A number of studies have been conducted in British Columbia where geomorphologic, soils, and vegetation information have been used to assess flooding susceptibility of streams (Miles and Harding, 1980) and alluvial fans (Thurber Consultants, 1983).

Table 2.13, adapted from Miles and Harding (1980) and Kellerhals *et al.* (1981), provides biophysical characteristics commonly associated with different flood hazard classes. It is intended as a guide and can be modified for specific project areas. For example, specific vegetation species can be related to the frequency and duration of flooding (Clement, 1985). For more information on biophysical techniques for flood hazard assessment, including mapping, refer to Miles (in press). Record flood hazard by circling only one category on the Site Description Form.

Table 2.13 Flood hazard characteristics (adapted from Miles and Harding, 1980, and Kellerhals *et al.*, 1981)

Flood Hazard (code)	Litter Cover	Overbank Deposits	Fluvially Transported Debris	Vegetation	Topography	Terrain	Soils	Flood Frequency
(a) Frequent and Irregular* (b) Frequent**	No litter or a thin layer of non-decomposed material.	Recent organic or inorganic deposits may be present. Occasional scour holes may be present.	Fluvially deposited logs or organic debris on channel banks. Occasionally debris in lower branches of trees.	None, or species typical of primary colonization, or species typical of wetlands.	Low lying areas.	Active flood-plains, or fans. Includes active channels and areas of marsh or swamp.	Usually lack A and B horizons. Regosolic or Gleysolic soils are common.	Subject to annual flooding.
(c) May Be Expected (or occasional)	Thin litter cover usually ranging from recent to partly decomposed material.		Fluvially deposited logs and organic debris may be present.	Mature vegetation, possibly containing some species typical of primary colonization.	Areas of moderate elevation.	Area of valley flat which may contain drainage or abandoned river channels.	Usually lack B horizons; buried LFH horizons often present; Regosolic or Gleysolic soils are common.	Occasionally flooded.
(d) Rare	Thicker litter cover; lower part partially decomposed.	No evidence of "recent" organic or inorganic overbank deposits.	Usually not present.	Mature vegetation including secondary colonizers.	Areas of high elevation.	Areas of low terraces and/or generally inactive portions of fans.	B horizon, if present, usually weakly developed. Brunisolic, Regosolic and Gleysolic soils are common.	Subject to flooding at high stage.
(e) No Hazard or Unlikely	Thicker litter cover; lower part often completely decomposed.		Not present.	Mature vegetation consisting of secondary colonizers preferring drier site conditions.	Areas of higher elevation	Areas of higher terraces and/or inactive portions of fluvial fans.	B horizons usually present; generally not Regosolic soils.	Unlikely to be flooded under the present hydrologic and channel conditions.

* "frequent and irregular" is used when flooding follows heavy rainstorms.

** "frequent" is used where flooding is associated with spring freshets due to snow melt.

35. DEPTH TO . . .

Record here the measured depths (in centimetres) that are evident from a soil pit or exposure. Depths should be measured downward from the top of the control section (in mineral soils, from the top of the mineral horizons; for organic soils, from the surface). If 0 cm is recorded for mineral soils, the feature is encountered either in the LFH horizons or at the top of the mineral soil (more detail may be recorded on the Soil Description Form). To indicate that a feature has been checked, but is absent, place an "X" in the "shaded" column, to the right of the decimal.

a. ***Water table*** — refers to the measured depth of the water table existing at the time of sampling; it is not inferred from evidence such as mottles or gleying. The water table is the surface of the zone of water saturation. Time should be allowed for the water level to reach equilibrium in the soil pit.

b. ***Rooting (effective)*** — this somewhat subjective assessment indicates the depth at which the rooting abundance class declines to "few". It is applied in natural vegetation only (i.e., uncultivated land). For cultivated land, insert an "X" in the right-hand shaded column. Refer to Chapter Three for definition of "few" roots.

c. ***Root restricting layer*** — refers to the depth at which a soil layer or condition severely restricts root penetration. A root restricting layer results in no greater than 'few' roots. Examples of restricting layers include many types of pans, cemented or indurated horizons, compact parent materials, chemical concentrations such as salts, bedrock, and saturated soil conditions.

d. ***Frozen layer*** — refers to the depth to a frozen layer in the soil at the time of sampling.

e. ***Bedrock*** — refers to the depth to consolidated bedrock. Highly weathered bedrock (such as some shale or phyllite) is sometimes difficult to distinguish from the regolith. As a general guide, if the material can be excavated by hand shovel, it should be considered as part of the regolith.

f. ***Carbonate*** — refers to the depth at which a zone of either inherent or secondary carbonate accumulation occurs. The zone is often identified by either the presence of white crystals, or strong effervescence on application of 10% HCl.

g. ***Salinity*** — refers to the depth at which saline soil conditions occur. These are sometimes identifiable by the presence of salt crystals in veins or crusts. Electrical conductivity is at least 4 mS/cm.

36. BEDROCK TYPE

This category provides a simple framework for describing various rock types in the field. It allows for either a general bedrock description using easily observable features requiring little geological knowledge, or for the recognition of specific rock types. Table 2.14 is a key that grades from general rock characteristics on the left to specific rock types on right. The surveyor can stop at whatever level is appropriate. General characterstics are coded as either one or two letters, while specific rock types are recorded using two letters and a two-digit number (e.g., Intrusive Acid Granite is IA02). Two bedrock types can be recorded and listed in order of dominance. The general rock characteristics are briefly described in the following discussion.

When coding bedrock type, enter the one or two alphabetic characters left justified in the first two columns, and the two numeric characters right justified in the last two columns. If the specific bedrock type is unknown, the numeric portion is left blank. An example where two bedrock types are indentified, is coded as follows:

1	I	A	0	2
2	I	B		

This example indicates the dominant presence of granite (IA02), with a lesser presence of Intrusive Basic bedrock (IB) whose specific rock type is unknown. Table 2.14 provides the names and codes to be used for bedrock description.

Table 2.14 Bedrock type classification and codes

IGNEOUS Usually crystalline massive non-foliated with porphyry non-calcareous	Ⓘ INTRUSIVE Usually coarse grained massive	Ⓐ Acid (Felsic) Usually light colour high % SiO_2		01 Syenite 02 Granite 03 Quartz Monzonite 04 Granodiorite
		Ⓘ INTERMEDIATE Usually medium colour medium % SiO_2		05 Quartz Diorite 06 Diorite
		Ⓑ BASIC (Mafic) Usually dark colour low % SiO_2		07 Quartz Gabbro 08 Gabbro 09 Pyroxenite 10 Peridotite 11 Dunite
		Ⓡ PORPHRY (>25% volume of phenocrysts)		can be used with 01 to 11
	Ⓔ EXTRUSIVE Usually fine grained lava flow structures glassy, bubbly	Ⓐ ACID (as above)		12 Trachyte 13 Rhyolite 14 Dacite
		Ⓘ INTERMEDIATE (as above)		15 Andesite
		Ⓑ BASIC (as above)		16 Quartz Basalt 17 Basalt
		Ⓟ PYROCLASTIC Usually fragmental		18 Tuff 19 Volcanic Breccia 20 Agglomerate
		Ⓡ PORPHRY (>25% volume of phenocrysts)		can be used with 12 to 20
METAMORPHIC Usually grains distorted crystalline	Ⓕ FOLIATED visible parallel structure (banded) oriented grains	Ⓕ FINE GRAINED (microscopic)	Low Grade	21 Slate 22 Phyllite 23 Greenschist 24 Schist
		Ⓜ MEDIUM GRAINED (hand lens helpful)		25 Muscovite Schist 26 Chlorite Schist 27 Biotite Schist 28 Garnet Schist 29 Kyanite Schist 30 Gneiss 31 Granite Gneiss 32 Diorite Gneiss
		Ⓒ COARSE GRAINED (easily visible by unaided eye)	High Grade	33 Gabbro Gneiss 34 Banded Gneiss 35 Augen Gneiss 36 Migmatite
	Ⓝ NON-FOLIATED lack visible parallel structure	Ⓕ FINE GRAINED (as above)	Low Grade	37 Argillite 38 Quartzite 39 Hornfels
		Ⓜ MEDIUM GRAINED (as above)		40 Soapstone 41 Serpentinite 42 Granulite
		Ⓒ COARSE GRAINED (as above)	High Grade	43 Amphibolite 44 Hornblendite
		Ⓚ CALCAREOUS		45 Marble 46 Dolomite Marble 47 Serpentine Marble
SEDIMENTARY Compacted or cemented grains may be calcareous bedded and sorted	DETRITAL OR CLASTIC non-crystalline often friable Ⓚ Calcareous cementation Ⓓ Non-Calcareous cementation	Ⓕ FINE GRAINED (less than 1/16 mm)		48 Claystone 49 Siltstone 50 Mudstone 51 Shale
		Ⓜ MEDIUM GRAINED (1/16 mm - 2 mm)		52 Sandstone 53 Greywacke 54 Arkose
		Ⓒ COARSE GRAINED (>2 mm)		55 Conglomerate 56 Breccia
	Ⓟ PRECIPITATES crystalline colloidal	Ⓚ CALCAREOUS (effervesces with HCL)		57 Travertine 58 Limestone 59 Dolomite
		Ⓓ NON-CALCAREOUS		60 Gypsum 61 Chalcedony 62 Limonite
	Ⓞ ORGANIC organic residue visible fossilized	Ⓚ CALCAREOUS (effervesces with HCL)		63 Oolitic Limestone 64 Fossiferous Limestone 65 Marl
		Ⓑ CARBONACEOUS (black in colour)		66 Lignite 67 Coal

What are Rocks?

Rocks can be defined as aggregates of minerals. Specific rock types are recognized by the types, amounts, sizes, and structural relationships of the mineral grains composing the rock. These characteristics are a direct reflection of the way in which the rock was formed, and also determines how a rock will decompose through weathering. For example, rocks that have large crystals and a high content of silica weather slowly and offer little soil nutrition. Conversely, fine grained rocks containing mostly dark coloured minerals weather more rapidly and form nutrient rich soils.

Rocks are found at the earth's surface either as separate fragments or in the formations in which they originally developed and which have been subsequently exposed through erosion. In the first instance the rocks are called *coarse fragments*, whether they are small pebbles or large boulders. In the second instance they are known as *bedrock*. The soils of an area are often influenced by the local bedrock of that area. However, if the soil parent materials have been transported (e.g., by glaciers or rivers), the soils may reflect a different bedrock source. In these cases the coarse fragments provide an indication of the actual source of the parent materials.

Rock Classification and Description

Geologists classify rocks according to three methods of formation: *igneous*, or rocks formed by crystallization from a melt; *metamorphic*, or rocks formed by recrystallization of former rocks under high pressures and/or temperatures; and *sedimentary*, or rocks formed by consolidation of materials transported and deposited at the earth's surface by gravity, wind, water, or ice.

IGNEOUS ROCKS are produced by the consolidation or cooling of magma or molten masses of essentially silicate composition. Magma is formed primarily by the melting of existing earth materials and incorporates variable amounts of volatile or vaporized elements.

Magmas that have been injected into cracks and fissures in the earth's crust and subsequently cooled in place are termed *intrusive* or plutonic igneous rocks. These are characterized by coarse-grained or large-sized crystals resulting from a slow cooling rate and extended time for crystal growth. They have cooled under pressures too great to allow the escape of magma gasses. Magmas that follow cracks and fissures to the earth's surface, and cool under atmospheric conditions of temperature and pressure, are termed *extrusive* igneous rocks. These are characterized by fine-grained or glassy (amorphous) textures, resulting from their rapid cooling. They often contain flow features (e.g., volcanic rocks) and bubbles, reflecting the escape of volatile constituents from the magmas.

Within each of the two main types of igneous rocks, individual rock types are identified on the basis of their chemical composition. Igneous rocks with high silica content are said to be *acid*; those with less silica but relatively more dark coloured, "mafic" minerals such as biotite, amphibole, and calcic feldspars are called *basic*. Those rocks containing about equal amounts of silica and mafic minerals are termed *intermediate*. Acid rocks are generally light in colour; basic rocks are dark.

METAMORPHIC ROCKS are the products of recrystallization of previously existing rocks and minerals. They are classified by terms descriptive of their structure, texture, genesis, mineralogy, and grade (degree of recrystallization and formation of new minerals). The recrystallization is caused either by high pressures, high temperatures, or both, each of which has characteristic effects. A common result is visible distortion in structure and appearance (termed *foliation*). It can vary from banding of light and dark minerals as in gneiss, to the flat, plate-like breakage planes or cleavages in slate, or to the smoothly undulating to severely folded cleavages in schist or serpentine. These structures are caused by the parallel orientation of elongated mineral crystals, aligned perpendicular to the direction of pressure.

"Low grade" metamorphic rocks often closely resemble their "parent" rock, and are sometimes difficult to distinguish from the original. As grade increases, the orientation and foliation of minerals also increases and new minerals form from old ones: clays become higher grade micas; some micas become garnets, etc. "High grade" metamorphic rock is nearly igneous because it has developed from rock almost remelted to magma. Medium to high grade metamorphics are termed gneiss or schist and modified by their major mineral components (e.g., kyanite, garnet or mica schists, diorite gneiss).

SEDIMENTARY ROCKS were depositionally formed in nature by mechanical means (gravity, water, etc.), by chemical means (evaporation, solution depositions such as colloids), and by organic accumulations (skeletal shells and vegetative matter). They are characterized by bedding or layering, and by other structures such as ripple marks, mud cracks, or fossils. Sedimentary rocks are classified on their mode of formation, which defines their ultimate texture and structure: *detrital* (or clastic), *chemical* or (evaporates), and *organic*.

Detrital rocks are those that are formed mainly by mechanical means. The cemented particles are called "clasts" and the size and shape of these form the basis of their classification. For example, rock formed from cemented, clay sized particles is claystone, while sandstone and arkose are clastic rocks of intermediate grain size. Sedimentary rocks with clasts larger than 2 mm are called conglomerates if the clasts are round; breccia if the clasts are angular. The composition of the cementing agent is also of importance, and can be noted, for example, as calcareous or siliceous.

Sedimentary rocks that are chemically precipitated may have crystalline or amorphous structures, but exhibit no evidence of clastic deposition. They can result from complex chemical deposition on sea floors or from crystallization following evaporation of saline waters. Limestone and dolomite are examples. They are often interbedded with detrital sedimentary rocks.

Organic sedimentary rocks are composed primarily of the remains of once living organisms (e.g., coal). They are characterized by the presence of fossils and are either carbonaceous or calcareous.

For more information, the following references are suggested:

American Geological Institute. 1962. *Dictionary of Geological Terms*. Doubleday & Co., Garden City, N.Y.

British Columbia Department of Mines. 1970. *The Identification of Common Rocks*. Queen's Printer. Victoria, B.C.

Ernst, W.G. 1969. *Earth Materials*. Prentice-Hall Inc. Englewood Cliffs, N.J.

Prinz, M., Harlow, G., Peters, F. (eds.) 1978. *Simon and Schuster's Guide to Rocks and Minerals*. Simon and Schuster, Inc. Milan, Italy.

Spock, L.E. 1963. *Guide to the Study of Rocks*. Harper and Rowe, Inc. New York, N.Y.

Travis, R.B. 1965. *Classification of Rocks*. Quarterly of the Colorado School of Mines, Vol. 50:1.

37. BEDROCK STRUCTURE

Bedrock formations have gross structural features characteristic of their mode of origin. Identification of these features assists in rock identification, and may be useful for making engineering interpretations. The following, briefly described structural features include kind and intensity of structure, strike, and dip. The appropriate codes are given in Table 2.15.

Kind of Structure

Bedding is the occurrence of more or less parallel rock layers caused by stratification during deposition of sedimentary or extrusive igneous rocks. When originally deposited, the beds were generally horizontal; however, through tectonic movements the original beds may be tilted or folded into a wide range of angles and shapes.

Foliation results when elongated minerals are oriented perpendicular to pressure forces. The dip of these can also be described, in relation to a horizontal plane, for metamorphic rocks.

Jointing is rock fracturing not related to bedding or foliation. Jointing results from tectonic movement or by shrinkage during the release of pressure as rock formations are exposed by erosion to the earth's cooling or drying surface. Jointing can predominate in a single plane, or in a number of planes.

Massive refers to rock formations having no visible structure.

Strike and Dip

Strike and dip refer to the orientation of a plane. The plane may be a bedding plane, a joint surface, or a foliation surface. The *strike* of a plane is the direction of a line formed by the intersection of that plane with the horizontal. *Dip* is the angle at which the plane is declined from the horizontal. The general direction of the declination is also given with the dip angle and must be one of the following: N, S, E, W, NE, NW, SE, SW.

Strike direction and dip angle are both recorded as degrees. Thus, a full strike and dip reading would be as follows: 310-48 NE. In this example, the direction of strike is 310°, the angle of dip is 48°, and the direction of dip is to the northeast (NE).

If the angle of the dip is 90°, the direction of the dip is not recorded. If the angle of dip is 0°, neither the strike nor the direction of dip are recorded.

Intensity of Structure

Intensity of structure refers to the average spacing between the planes, or the average thickness of the strata. Five classes are described in Table 2.15.

Table 2.15 Codes used for bedrock structure

Kind of Structure	Code
Bedding	B
Foliation	F
Jointing	J
Massive	M

Strike and Dip

XXX — yyAA

XXX is direction of strike in degrees (270-359, 0-90)

yy is angle of dip in degrees (0-90)

AA is direction of dip (N, S, E, W, NE, NW, SE, SW)

Intensity of Structure		
Desc.	Average Spacing (cm)	Code
Very thin	<5	1
Thin	5-30	2
Medium	30-90	3
Thick	90-300	4
Very thick	>300	5

How to Code

Record bedrock structure by first coding kind of structure, then dip and strike, and lastly, intensity of structure. Two long boxes are provided, corresponding with the appropriate bedrock types recorded in Item 36. In either the upper or lower box, up to three separate entries are allowed. The only restriction is that within either box, combinations of bedding, foliation, and massive are not allowed. For massive bedrock, neither strike, dip, nor intensity of structure are recorded since they do not apply (i.e., record only "M").

Angle of dip and intensity of structure, when recorded, should always be preceded by a dash, and separate entries within a box should be separated by a semicolon. The following are two examples of how to code the Site Description Form. Up to thirty-five characters of information can be entered in free format (left justified).

B150-10SW-2	Example 1
M; J50-90-3	Example 2

In example 1, the main bedrock type has bedding structure, whose direction of strike is 150° and angle of dip is 10° to southwest, and intensity of structure is thin. The secondary bedrock type in example 2 is mainly massive, however, some medium intensity jointing occurs with 50° strike, and 90° dip.

38. COARSE FRAGMENT LITHOLOGY

The rock type(s) that makes up the coarse fraction (e.g., cobbles and stones) of the soil material is recorded under Coarse Fragment Lithology. Because there often is more than one type, the option of recording up to three types is available (listed in order of dominance from left to right). Characters are entered on the data form in the same format and using the same codes as outlined previously for the categories of bedrock type under Item 36 and in Table 2.14.

If the lithologies are so mixed that a dominance cannot be determined, denote mixed by entering a "1" in space 137. In cases where there are no coarse fragments, such as in some lacustrine silts, place an "X" in the shaded character space 125.

39. SUCCESSIONAL STATUS

The description of plant community succession presented here has been adapted and synthesized from a number of workers. It has not yet been fully documented, but is outlined here to facilitate a consistent use of terms. Hamilton (1986) has provided a review of this system and many others and has suggested further research into development of a successional classification system.

Tansley (1935) defines succession as "the gradual change which occurs in the vegetation of a given area of the earth's surface, on which one population succeeds the other" (Mueller-Dombois and Ellenberg, 1974). This change is determined by the composition of each population, by their reproduction and distribution on the substrate, and by the conditions of their coexistence, which are created by two mutually counteracting processes: competition between individuals; and favourable effects of one organism on another (Sukachev and Dylis, 1964).

Succession is the process in which an area of land (either newly created, exposed, or produced by the removal of an "original" plant community) is colonized consecutively by a number of plant individuals. As the number of individuals increases on the area, interspecific interactions begin to occur and certain species are replaced. This process continues through a number of more or less distinct stages termed 'seral', until interspecific and inter-individual interactions stabilize.

This final stage, termed 'climax', is one of relative stability, in which the species present perpetuate themselves and changes in the plant community occur very slowly in response to gradual environmental or evolutionary change (Sukachev and Dylis, 1964; Mueller-Dombois and Ellenberg, 1974). In a climax community the species composition generally remains the same over a relatively long period of time. A climax community is not a static entity, but is in a state of equilibrium. There is a continuous turnover in individuals of a species through mortality and replacement but a progressive change in the composition of the plant community does not occur.

A climax forest stand, for example, is characterized as having a full range of age classes and a more or less continuous height class distribution. However, the proportions of individuals in each age or height class and the relative proportion of species between layers may differ. A climax grassland community might be characterized by a stable, self-perpetuating community, dominated by perennial bunchgrasses mixed with forbs and annual grasses.

The definitions given here pertain primarily to stages of secondary succession. Secondary succession occurs after the destruction of some or all of the previously existing vegetation, generally through logging or fire.

The model in Figure 2.10 illustrates an idealized successional sequence of a forested site that proceeds through two generations of trees to reach the climax stage. It depicts a situation in which lodgepole pine (*Pinus contorta*) is the seral tree. The pine becomes established and begins to form a canopy (Young Seral). These trees continue to grow and the canopy becomes relatively closed in an even-aged stand (Maturing Seral). At the same time, climax or more shade tolerant species such as western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), begin to establish in the understory. As the pine begins to die, the canopy becomes more open (Overmature Seral) and the climax species (redcedar and hemlock) begin to be part of the overstory. As the pine continues to die, a canopy of redcedar and hemlock develops, containing individuals of all age and height classes as a result of regeneration (Maturing Climax).

Another sequence occurs where succession proceeds through one generation of trees to climax (Figure 2.11). Consider, as an example, Engelmann spruce (*Picea engelmannii*) regenerating on a wet site following severe disturbance. The community proceeds from the Pioneer Seral stage, to an even-aged stand of spruce with a relatively closed canopy (Young Climax). The canopy then begins to open as some trees die; spruce continues to regenerate in the understory; and, the stand becomes increasingly all aged and approaches a continuous frequency distribution of heights (Maturing Climax).

Other variations of these models exist, and the models may not apply in all cases. In grassland areas, for example, models of successional patterns need to be developed. Although successional sequences do occur in these areas, they are often difficult to assess because of the effects of grazing, and because community structure is not as apparent as in forest communities. However, the terms as defined in the following discussion should be applied.

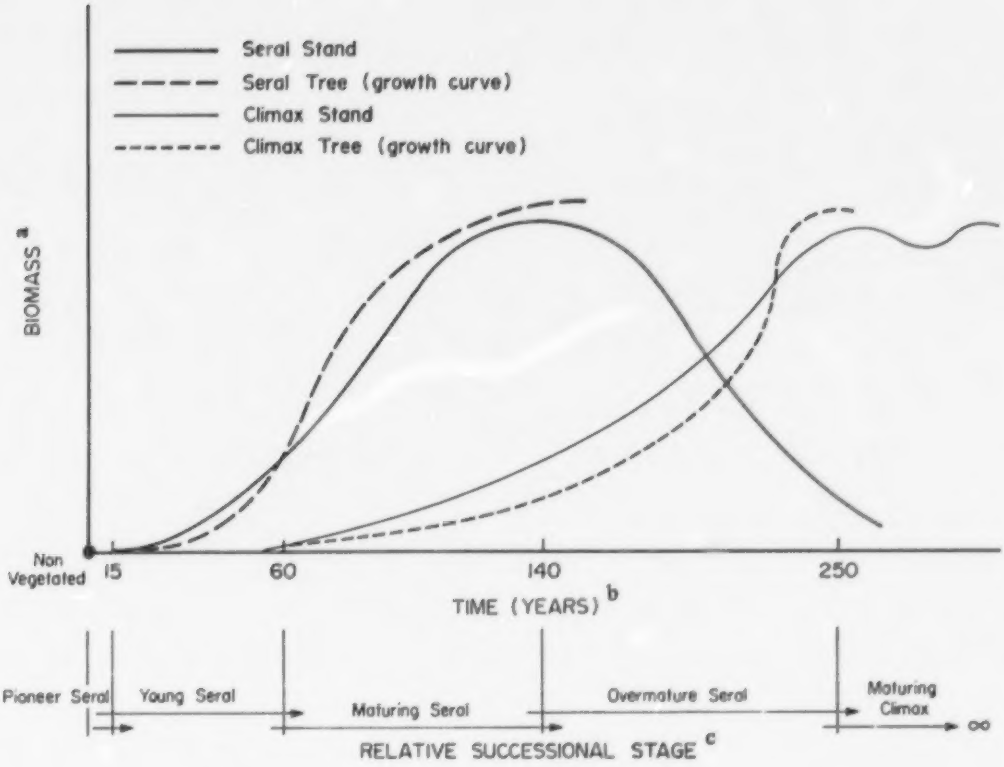


Figure 2.10 A hypothetical model depicting the idealized secondary successional sequence of a forest stand, passing through two generations of trees

a The scale for biomass is different for each curve.

b Time represents approximate ages for a typical stand in the Interior. The time scale may be shorter or longer for different parts of the province, different subzones, or different edaphic situations in a subzone.

c Successional stages are defined in a following discussion.

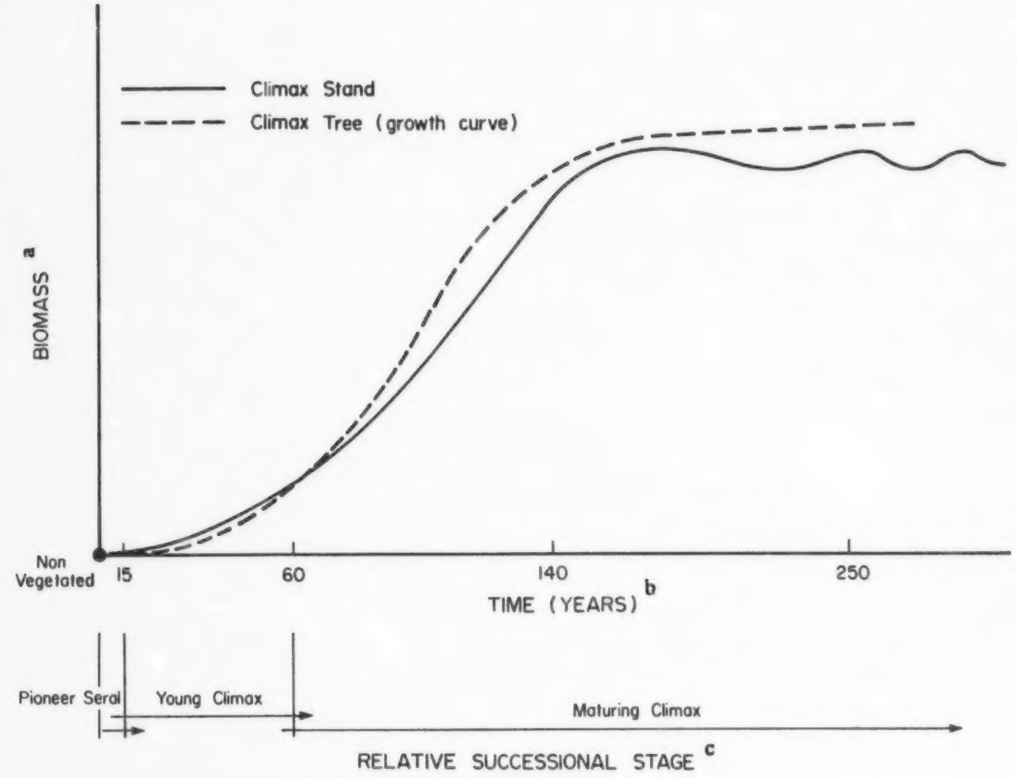


Figure 2.11 A hypothetical model depicting the idealized secondary successional sequence of a forest stand where climax tree species form the successional stand

a Scale differs for each of the curves.

b Time is approximate and may differ depending on location (subzone) and site.

c Successional stages are defined in a following discussion.

Discussion of Climax

The term 'climax' characterizes a self-perpetuating community whose species composition is expected to be relatively stable and long term. Climax stands are differentiated into two stages, "Young" and "Maturing", based on the development of their stand structure and age-class distribution. These stages can be further divided into "climatic" (zonal) and "edaphic" (azonal) climax.

Climatic climax communities, in a given climatic area (e.g., biogeoclimatic subzone), occur on soils that reflect a moisture status equivalent to that expected for the climatic conditions. Soils are typically deep, medium textured, and well to moderately well drained, and occur in middle meso slope positions. Occasionally, counteracting factors that also support a climatic climax community may take place; for example, coarse-textured soils receiving some seepage water.

Edaphic climax communities occur where soil or topographic factors control the site's vegetation more than the prevailing macroclimate (Mueller-Dombois and Ellenberg, 1974). Examples of such sites are those with excessive moisture, rapid drainage, very shallow soils, or exposed bedrock.

In most parts of the province, precipitation is sufficiently low so that no excessive moisture remains in most medium textured soils. As well, in mountainous terrain, moisture is transmitted through the soil to the lowest areas in the terrain, collecting in depressions. This groundwater is usually well oxygenated and does not interfere with tree growth on its way downslope. However, when this water becomes abundant in localized areas as seepage near the surface, it creates wetter moisture regimes and results in forest or non-forest communities with different species and stand composition than the climatic climax (i.e., an edaphic climax). If moisture collects in depressions and becomes stagnant, only species adapted to low oxygen conditions will grow and entirely different plant communities will develop, which are also edaphic climaxes. Similarly, in upper slope positions moisture may be lost very rapidly, providing communities that reflect distinctly drier conditions than those expected for the climatic climax, and these are also edaphic climaxes.

In some parts of the province with high precipitation, the percolation rate of medium textured soils is not sufficient to prevent an accumulation of moisture. This becomes especially apparent in areas of subdued terrain where the lateral movement of moisture is minimal. In such areas the process of paludification may occur where "bog" vegetation, initially developing in depressions, spreads over higher ground and becomes widely established. This bog vegetation is thought to be the end point of succession in the boreal forest (where permafrost has a role in paludification) and in wetter parts of the coast. The process is considered to be primarily climatic, although regional topography plays an important role as well. The "bog" vegetation developed on medium textured soils in middle meso slope positions is considered the climatic climax in contrast to areas of lower precipitation where bog vegetation only occurs as an edaphic climax in moisture-collecting sites.

Present Stage

The categories for present successional stage, as used in the models (Figures 2.10 and 2.11), are explained below. Only one category should be circled on the Site Description Form.

Non-Vegetated (NV)

This category is comprised of the earliest successional stage where vegetation is either absent or very sparse. It usually consists of areas with recent severe disturbances such as mass-wasting or flooding, but also includes areas of exposed bedrock where the weathering cycle has proceeded only to an early stage. These bedrock areas support some lichens and other bryophytes. Examples of non-vegetated areas include rock faces usually with talus at the foot, recent erosion scars, ice or permanent snowfields, areas subjected to recent and usually severe fires, and gravel pits.

Pioneer Seral (PS)

This is the first stage where vegetation occupies a site following disturbance. The disturbance has eliminated the original plant population; humus layers and seeds originally present on the site may have been disturbed or eliminated. This stage may result from fire, logging, scalping of the soil surface, or be the next stage of development on talus slopes or erosion scars. Herb and/or shrub species are usually dominant.

Young Seral (YS)

This stage refers to seral stands or communities (other than pioneering communities or communities dominated by species expected at climax) that have not yet gone through a series of natural thinnings. The stand is young (generally less than 60 years old in forest stands in the Interior) and stand density is a reflection of species establishment. Competition between individuals of the stand may be occurring but this has not imparted structure to the community (i.e., the stand is young and even-aged, the canopy is more or less of an even height).

The dominant plants are essentially growing as independent individuals rather than as members of a phytosociological community; that is, roots, stems, and crowns develop in accordance with the potential of the plant and the site, and as a result of competition between individuals of the same species.

The term applies in the case of the first model (Figure 2.10), where the stand goes through two generations of dominants before reaching climax, but does not apply in the case of the second model (Figure 2.11). The idealized stand structure is illustrated in Figure 2.12a.

Maturing Seral (MS)

This stage is represented by seral stands (other than pioneering stands or stands dominated by climax species) of mature age (generally between 60 and 140 years old in Interior forests). These stands have gone through an initial natural thinning stage as a result of species interactions.

The plants are growing as members of the plant community and a community structure is evident. Community structure means that the seral stand is no longer composed of one age class, but has one age class in the overstory with some regeneration occurring that is in a very much younger age class. The younger age class is composed of seral dominant species, and/or climax (future dominant) species, and/or species with greater shade tolerance. This stage applies only in the case of the first model (Figure 2.10) where the stand goes through two generations of dominants before reaching climax. Figure 2.12b is a schematic diagram of the idealized stand structure at this stage.

Overmature Seral (OS)

This stage applies to stands dominated by seral overstory species of "decadent" age (in the Interior forests, usually more than 140 years old). These stands have reached the stage where the seral species (trees) composing the main upper (tree) canopy are dying and providing room for the next generation. The next generation may be composed of predominantly the same seral species but in a different proportion, different species that are either more shade tolerant or competitively more successful, and/or climax species.

Frequently, there is a secondary tree canopy that is approaching a more even height class distribution. An evident gap usually exists between the dominant height class and the secondary tree canopy. Some individuals of the next generation may have entered the main canopy. Typically, stand biomass or volume is declining because of mortality. This stage applies only in the case of the first model (Figure 2.10). Idealized stand structure is illustrated on Figure 2.12c.

Young Climax (not present on Site Description Form; code as *YCC or YEC*)

This refers to the stage of succession in which the stand is composed of the same species in generally similar proportions as the climax for the site, but has not developed the community structure expected at climax. It represents an early stage in the development of a climax stand (in relation to the model in Figure 2.11), where the climax species form the successional stands. The young climax stand differs from the climax in being even-aged and young (generally less than 60 years), and having a uniform canopy (a small range in height).

As with the young seral stage, stand density in a young climax stand is a reflection of species establishment. Competitive factors have not yet resulted in a distinct structure of overstory and understory vegetation, and spacing of trees. These stands usually undergo natural thinnings and pruning prior to reaching the maturing climax stage. This stage itself is not indicated on the Site Description Form, but depending on the site and the community composition, should be coded as either young climatic climax or young edaphic climax. Figure 2.12d depicts idealized stand structure at this stage.

Young Climatic Climax (YCC)

This stage refers to young stands (usually less than 60 years old in the Interior) composed of the same species expected in climatic climax stands. It occurs where a successional pattern similar to the second model (Figure 2.11) is operating, and is a parallel to the young seral stage of the first model. Young climatic climax stands differ from young seral stands in that they are composed of the species expected at climax, not of seral species.

The structure of young climatic climax stands differs from maturing climatic climax stands in being more or less even-aged and of uniform height class. Both are composed, however, of the same species expected at climax on a typical "zonal" (mesic moisture, mesotrophic nutrient regime) site.

Young Edaphic Climax (YEC)

This stage applies to young stands (usually less than 60 years old) composed of the same species expected at climax on a site edaphically different from a "zonal" (climatic) site. The young edaphic climax stage differs in stand structure from the maturing edaphic climax in being more or less even-aged and of uniform height class. Examples include a young spruce stand on a wet site, or a young Interior Douglas-fir stand on a dry, south facing slope in a wetter climate.

Maturing Climax (not present on Site Description Form; code as *MCC or MEC*)

This stage describes stands composed of the species expected to form the climax stand on the site (either edaphic or climatic). It differs from the young climax in having a continuous age and height class distribution, although a gap may exist between the older or upper class and the next youngest or highest class. The stand has experienced natural thinning and has developed a structure similar to that expected at climax. Some remnants of seral stands may remain, but they should not have any effect on the density or structure of the stand. Removal of a seral tree would not cause a significant response in the growth or establishment of the climax trees. This stage occurs in both models of forest succession (Figures 2.10 and 2.11). According to stand and site conditions, indicate either maturing climatic climax or maturing edaphic climax on the Site Description Form. Figure 2.12e depicts idealized stand structure at this stage.

Maturing Climatic Climax (MCC)

This stage depicts stands approaching a continuous age and height class distribution and composed of the species representative of the climatic climax. Such stands would be at least 60 years old in Interior forests, but are usually much older (about 200 years). A gap may exist in the age and height class distributions between the members of the main canopy and the continuous age and height class distribution of the regeneration. Also, the proportions of each of the climax species in each height class may differ from that of the main canopy because of differential survival of species. Some variability in the relative abundance of the climax species may occur between different sites.

Maturing Edaphic Climax (MEC)

This stage also refers to stands approaching a continuous age and height class distribution. A maturing edaphic climax, however, usually differs from the climatic climax in species composition. This may be only a minor difference in the relative proportions of the climax tree species (e.g., abundant redcedar with a few western hemlock on a subhygric site in an area where the climatic climax is predominately western hemlock with a few redcedar), but there may be a major difference in understory species composition (e.g., oak fern dominated understory versus one dominated by devil's club).

Soil properties differ from those occurring on the climatic climax site, primarily in terms of soil moisture and nutrient regime. In some cases, obvious differences in soil properties from those representing the climatic climax may occur, with only minor differences in stand composition. In such cases, where there are clearly defined differences in the soil factors, the site is considered to be a maturing edaphic climax.

Some typical examples of maturing edaphic climaxes are: grassland communities on coarse textured or shallow soils in a forested Interior Douglas-fir subzone; spruce — horsetail communities on floodplains in areas where the climatic climax communities are characterized by spruce with a moss understory; or, bogs and fens.

Disclimax (DC)

This stage refers to a special case of a maturing climax where the stand strongly differs in species composition from the climax (either edaphic or climatic) expected for the site. This is a self-perpetuating climax community resulting from permanent changes to the physical characteristics of the site following disturbances such as fire, intensive grazing, or mining. The disclimax community must remain even after the disturbance has stopped.

Expected Climax

The dominant species likely to form the climax stand are recorded on this line of the Site Description Form. Use the tree symbol codes in Table 5.3 for forest stands (e.g., Hw, Cw is coded where the climax stand is expected to be composed of western hemlock and western redcedar). A maximum of 30 characters can be coded if a more precise identification of expected climax species is desired; for example, a listing of major understory species.

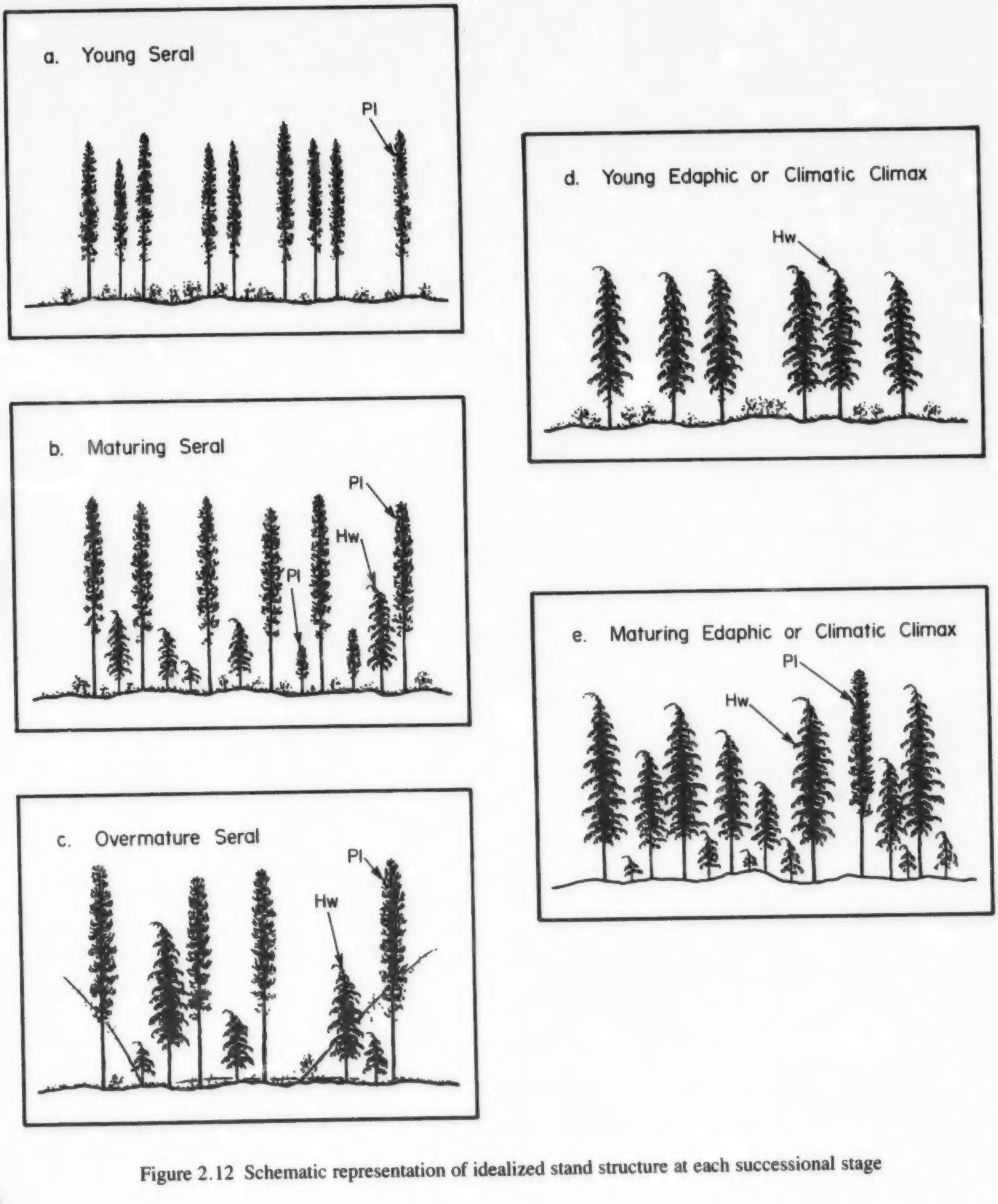

a. Young Seral
Pl
b. Maturing Seral
Pl
Hw
Pl
c. Overmature Seral
Pl
Hw
d. Young Edaphic or Climatic Climax
Hw
e. Maturing Edaphic or Climatic Climax
Pl
Hw

Figure 2.12 Schematic representation of idealized stand structure at each successional stage

Rate of Succession

For forest environments, rate of succession refers to the anticipated time that it will take to develop a normally (satisfactorily) restocked stand following disturbance (such as logging or fire), and to develop a young or mature coniferous forest. Rate of succession is an interzonal concept. For example, mesic sites in dry climates often have slow rates of succession, mesic sites in moist Interior forests often have normal rates, and mesic sites in coastal climates often have rapid rates. Rates of succession for environments where coniferous forest trees are not part of climax stands are more difficult to assess and guidelines have yet to be developed. Five categories are described below (circle only one on the form):

a. ***Very slow*** — a satisfactorily stocked stand following disturbance will normally not be developed within 30 years (satisfactory stocking doubtful). Examples: krummholz areas; sites severely disturbed by man; very dry sites.
b. ***Slow*** — a satisfactorily stocked stand will normally be developed between 7 and 30 years following disturbance. Mature stand development takes place in approximately 200-250 years. Examples: dry climates (e.g. forest/grassland transition areas); certain edaphic conditions such as dry, south aspects; areas where severe brush competition occurs.
c. ***Normal*** — a satisfactorily stocked stand will normally be developed in 3 to 7 years following disturbance. Mature stand development takes place in approximately 120-140 years. Examples: mesic sites in sub-boreal forests.
d. ***Rapid*** — a satisfactorily stocked stand will normally be developed within 3 years following disturbance. A young climax stand is often achieved in approximately 30 years. Example: many coastal forest stands, if brush competition not a problem.
e. ***Very rapid*** — a satisfactorily stocked stand will normally be developed within 3 years following disturbance, and a young climax stand often occurs within 15 years. Succession sometimes bypasses seral communities altogether. Example: An Engelmann spruce stand on a wet site, if brush competition not a problem.

Note that forest productivity does not necessarily increase with faster rates of succession. For example, many subalpine forests considered to have rapid succession rates, have low forest productivity.

40. FACTORS INFLUENCING STAND ESTABLISHMENT

Events relevant to the development of present vegetative cover and soil characteristics — insofar as these differ from the characteristic soil and climax vegetation of the site — should be recorded here. It is impossible to compile a complete list of potential influences affecting the soils and vegetation at a site, and additional categories may need to be described. Wherever possible, however, one or several of the categories listed below should be coded. The various factors are grouped into several general categories and these may be used when the specific categories cannot be determined.

The code listed beside each factor is used when recording the information on the Site Description Form. Use these codes or describe other factors in free format. Up to four factors may be coded and/or two entered as free format (beginning in spaces 58 and 98 respectively). For example, windthrow is coded "A3"; or, if the surveyor only knows that the factor is atmosphere related, it can be recorded as "A" (left justified). Where free format entries are used to elaborate on some of the codes, precede each comment by the applicable code (e.g., E3 Cattle or G6 Glyphosate).

A. Atmosphere related effects:
   1. Atmospheric pollution (specify type, e.g., toxic gases, acid rain)
   2. Climatic extremes (specify type, e.g., temperature — cold, heat; precipitation — glaze ice, hail, snow)
   3. Windthrow

B. Harvesting and soil disturbances:
   1. Abandoned construction sites (road bed, railway, etc.)
   2. Clearcut logging (no slashburn unless indicated)
   3. Cultivation (continued disturbance of the vegetation and/or the soil, excluding harvesting of native crop)
   4. Excavation
   5. Harvesting of native crop (haying, salal picking, etc.)

6. Land clearing (includes grubbing and/or other forms of disturbance of the natural soil as for pipeline construction, etc.)
7. Scarification
8. Selective logging (including shelter cut)
9. Soil compaction (including the effects of human and animal traffic, as well as machinery)

C. Dumping, disposal, and spills:
  1. Chemical spill or disposal (specify type)
  2. Effluent disposal
  3. Mine spoils
  4. Oil spill or disposal
  5. Radioactive waste disposal or exposure

D. Fires:
  1. Severe surface fire
  2. Light surface fire
  3. Repeated severe surface fires
  4. Repeated light surface fires
  5. Burning of logging slash — high intensity
  6. Burning of logging slash — moderate intensity
  7. Burning of logging slash — light intensity
  8. Overstory crown fire and severe surface fire
  9. Overstory crown fire and light surface fire

E. Plant and animal related effects:
  1. Beaver tree cutting
  2. Disease (excluding insects; specify type)
  3. Domestic grazing/browsing (specify animal)
  4. Excrement accumulation (other than that normally associated with grazing and browsing)
  5. Insect kill (specify insect)
  6. Succession (generation of vegetation including climax stands)
  7. Wildlife grazing/browsing (specify animals)

F. Terrain related effects:
  1. Avalanching
  2. Eolian (active deflation or deposition)
  3. Recent deglaciation
  4. Rock quarrying (including open pit mines)
  5. Terrain failures (active or recent slumps, slides, solifluction, etc.)
  6. Volcanic activity

G. Vegetation and site improvement related effects:
  1. Fertilization (specify fertilizer)
  2. Irrigation
  3. Planted to trees or shrubs
  4. Seeded or planted to grass or herbs
  5. Seeded to trees or shrubs
  6. Herbicide use (specify type)

H. Water related effects:
  1. Inundation (including temporary inundation resulting from beaver activity)
  2. Temporary seepage (usually man-induced; excludes intermittent seepage resulting from climatic conditions)
  3. Water table control (diking, damming)
  4. Water table depression (associated with extensive water extraction from wells)

Z. Miscellaneous:
  1. Other (specify and describe)

41. VEGETATION PLOT DIMENSIONS (Veg. Plot)

The area, shape, and dimensions of the sample plot are recorded here.

Area

Record the sum of the subplot areas, if subplots are used. If the area is readily determined from the shape and dimension information (i.e., shape is not irregular), the computer can automatically compute and store the area. Note that the smallest area that can be recorded is 0 . 0 1 ha or one square metre.

Shape

The first letter of one of the following words is coded: Circle, Square, Rectangle, Line (no width — e.g., some grassland surveys), Irregular. If subplots are used, it is assumed that they are all of equal size and shape. If they are not, then shape should be left blank and "Area" only should be entered.

Number (#)

The number of subplots are indicated here. Where there is only one plot (and no subplots), enter: __ 1.

Dimension

The radius or first dimension of the plot (in metres) is recorded under spaces "X". Where subplots are used, it is the radius or first dimension of the subplots. The second dimension of the plot or subplots (in metres) is recorded under spaces "Y".

42. HUMUS FORM CLASS (from Bernier, 1968)

Humus form class can be recorded according to either Bernier's (1968) system (as described here), or that proposed by Klinka *et al.* (1981) as described in Chapter Seven. The humus form taxa in Klinka *et al.* (1981) can be entered in the free format "phase" area (beginning in column 38) of Item 17 on the Site Description Form using the codes and procedures described in Chapter Seven.

The Humus Form Class (Item 42) is based on Bernier's (1968) system, with minor modifications. His original "Mull" type has been subdivided into "Zoomull" and "Rhizomull", reflecting the main source of humus materials incorporated in the Ah. Figure 2.13 illustrates the complete classification and Table 2.16 provides general chemical characteristics of the major humus types. Variants of humus forms are defined in Table 2.17. The following definitions apply to the major humus types.

Zoomull is a zoogenous humus form consisting of a porous mass characterized by mechanically inseparable complexes of colloidal organic matter and mineral soil. The structure of this "Ah" horizon is generally "crumb" or "granular". Zoomull humus forms ideally occur under temperate deciduous forests where conditions favour the development of actively burrowing soil fauna, particularly earthworms (*Lumbricidae*), which contribute to the mixing of the organic matter and mineral soil. Because of mixing by of these burrowing organisms, partially decomposed organic debris does not accumulate as distinct F and H horizons as is the case in Mor or Moder humus forms.

Rhizomull is a rhizogenous humus form extracted from Wilde's (1966) classification of humus types. It is characterized by a thin litter layer overlying a dark-coloured mineral/organic horizon where finely dispersed organic matter, mainly the residue from root systems, is incorporated with the mineral soil. This humus form typically occurs under grassland, forest/grassland transition, and alpine meadow communities.

Moder is primarily a zoogenous humus form comprised of partly decomposed plant remains (F horizon), which are not matted as in Mor humus. The F horizon is transitional to a Hi horizon made up of organic granules intermixed with loose mineral grains. Moders typically occur under mixed or hardwood forests, and under temperate coniferous forests where climatic and edaphic conditions are not favourable for the development of Mor or Mull humus forms. Moders characteristically occur in soils whose surface horizons contain little clay and are periodically droughty. Although incorporation of organic matter is intense, it is shallow, since none of the organisms involved in Moder formation are strong burrowers. There is little evidence of clay-humus complexes, unlike in zoomull humus forms. The mixing of organic and mineral particles may sometimes be caused by soil creep, although the action of micro-arthropods is the most common cause.

Mor, also known as "raw humus", is non-zoogenous and is comprised of Of, Om, or L, F, and H horizons which are sharply delineated from the mineral soil. It is usually strongly matted or compacted and often interwoven with fungal hyphae. Mors commonly occur in coniferous forests where climatic and edaphic conditions prevent the rapid decomposition of organic matter and development of active populations of soil microfauna. They can also occur under mixed or hardwood stands, and in wetland areas.

Terminology for Describing Humus Forms

To properly classify humus into one of the previous categories, a number of morphological features should be described in detail. The following list suggests a number of these that should be noted either on the Soil Description Form or on the Humus Form Description (Chapter Seven).

- designation of the horizons present in the humus profile (i.e., L, F, H, Hi, or Ah);
- thickness of each organic and mineral humus horizon;
- degree of incorporation of organic matter with mineral soil (i.e., presence of Hi and/or Ah horizon and degree of intermixing);
- degree of compaction or matting of the humus material or horizon, if applicable;
- presence of fungal mycelia, and an indication of the relative abundance and colour of the mycelia (e.g., brown, yellow, or white);
- presence, abundance, and type of roots present in each humus horizon;
- presence of decaying wood or charcoal in the humus horizons and an indication of the relative abundance of each (i.e., trace amounts of charcoal, abundant decayed wood, etc.);
- moisture status of the humus material (i.e., dry, moist, wet);
- general types and amounts of soil fauna, if present. Note them according to the general group they represent. If insect droppings are visible, describe the general size and amounts. These generally appear as tiny spherical or cylindrical pellets occurring singly or in clumps;
- origin of organic material from which humus is derived (e.g., primarily from mosses, xerophytic grasses, pine needles, aspen leaves, etc.).

How to Code

One humus class and up to four variants can be recorded on the Site Description Form. The humus class has six characters. The first two spaces are for Mor or Moder descriptions (if applicable). The first letter of one of the following may be used: Hypno, Sphagno, Licheno, Ericaceo, Conifero, or Deciduo. The first letter of one of the following may also be included: Granulo, Amorpho, Mycelio, or Rhizo. If only one descriptor is used, enter it in the first space (left justified).

Enter the subgroup code (i.e., the letters before the decimal in the list below) in the third and fourth spaces (*right justified*), and the great group in the fifth and sixth spaces. The codes are:

.MU	Mull	.MR	Mor
R.MU	rhizomull	F.MR	fibrimor
Z.MU	zoomull	HF.MR	humifibrimor
.MD	Moder	FH.MR	fibrihumimor
ML.MD	mull-like moder	H.MR	humimor
T.MD	typical moder	P.MR	peatymor
W.MD	raw moder	HP.MR	humic peatymor
		MP.MR	mesic peatymor
		FP.MR	fibric peatymor
		.AN	anmoor

For example, a conifero fibrimor is coded as follows: C __|__ F | M R

Up to four *variants* may be coded; one each for texture, moisture, acidity, and depth classes. The two letter codes are underlined: C L ayey, L O amy, or S A ndy; H Y dric, M E sic, or X E ric; A C id, S L ightly acid, N E utral, or C A lcareous; T hic K , or T hin N .

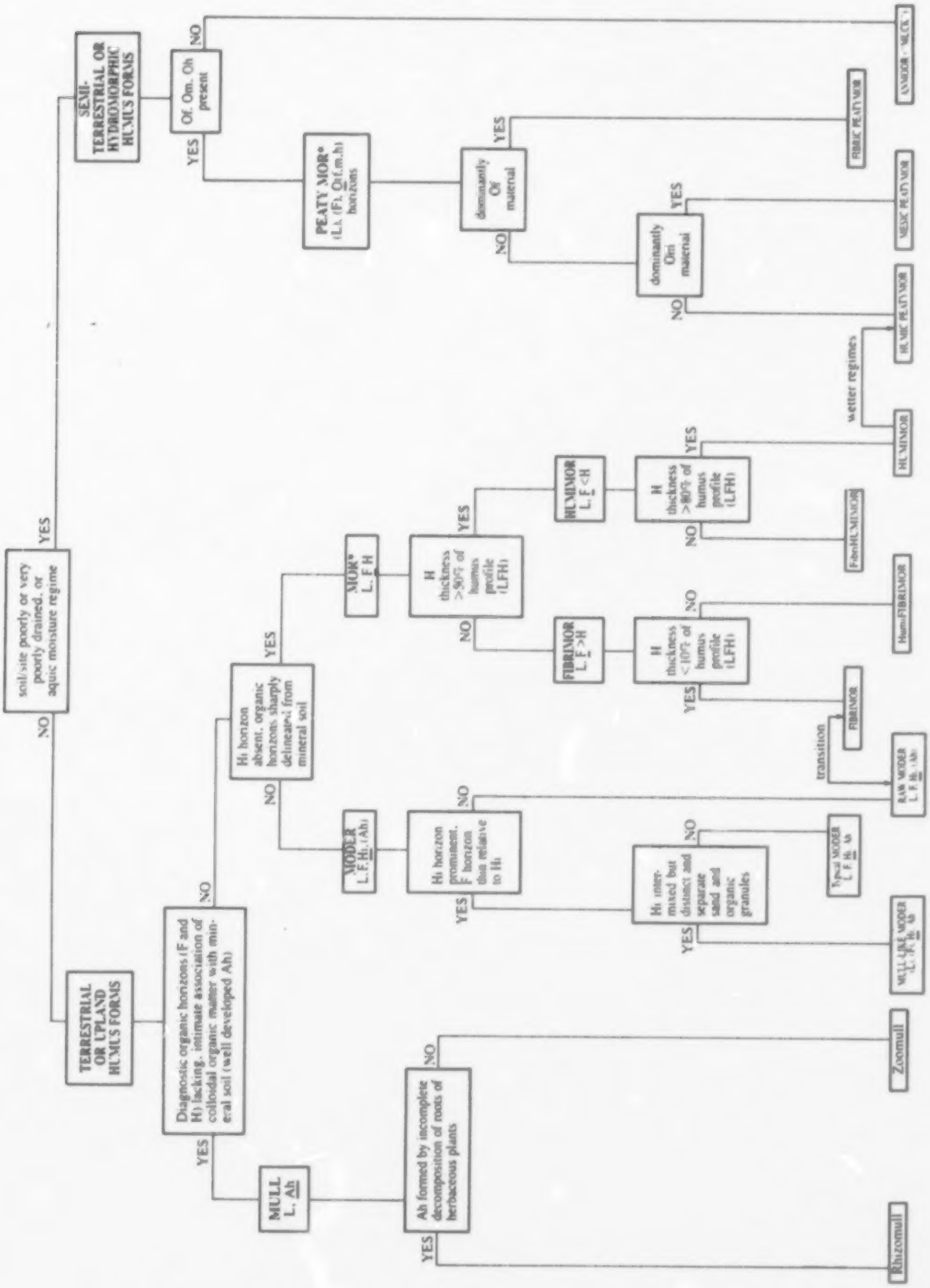

soil/site poorly or very poorly drained, or aquic moisture regime
YES
NO
SEMI-TERRESTRIAL OR HYDROMORPHIC HUMUS FORMS
Of, Om, Oh present
YES
NO
PEATY MOR* (L), (F), Of,m,h) horizons
dominantly Of material
YES
NO
dominantly Om material
YES
NO
FIBRIC PEATY MOR
MESIC PEATY MOR
HUMIC PEATY MOR
ANMOOR (MUCK)
wetter regimes
TERRESTRIAL OR UPLAND HUMUS FORMS
Diagnostic organic horizons (F and H) lacking, intimate association of colloidal organic matter with mineral soil (well developed Ah)
YES
NO
MULL L, Ah
Ah formed by incomplete decomposition of roots of herbaceous plants
YES
NO
Rhizomull
Zoomull
Hi horizon absent, organic horizons sharply delineated from mineral soil
YES
NO
MODER L, F, Hi, (Ah)
Hi horizon prominent, F horizon thin relative to Hi
YES
NO
Hi intermixed but distinct and separate sand and organic granules
YES
NO
MULL-LIKE MODER (L) (F) Hi Ah
Typical MODER L F Hi Ah
RAW MODER L F Hi (Ah)
transition
MOR* L, F, H
H thickness >50% of humus profile (LFH)
YES
NO
HUMIMOR L, F<H
H thickness >80% of humus profile (LFH)
YES
NO
HUMIMOR
FibriHUMIMOR
FIBRIMOR L, F>H
H thickness <10% of humus profile (LFH)
YES
NO
FIBRIMOR
HemiFIBRIMOR

Figure 2.13 Humus form classification (after Bernier, 1968)

Legend for Figure 2.13 Humus Form Description

DEFINITION OF HORIZONS

L,F,H: organic horizons developed primarily from the accumulation of leaves, twigs, and woody materials with or without a minor component of mosses; usually not saturated for prolonged periods (>17% organic C or approximately >30% o.m. by weight).

L: characterized by an accumulation of mainly leaves (and needles) twigs and woody materials in which the original structures are easily discernible.

F: characterized by an accumulation of partly decomposed organic matter derived mainly from leaves, twigs and woody materials; some of the original structures difficult to recognize; materials may be partly comminuted by soil fauna as in MODER, or it may be a partly decomposed mat permeated by fungal hyphae as in MOR.

H: characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible; differs from the F by having greater humification chiefly due to the action of organisms; it may be sharply delineated from the mineral soil as in a MOR where humification is chiefly dependent upon fungal activity, or it may be partially incorporated into the mineral soil as in a MODER (*see* Hi horizon).

Hi: an organic horizon, characterized by an accumulation of spherical or cylindrical organic granules (animal droppings) with considerable intermixing with mineral particles: genetically an intermediate stage between an H and an Ah horizon.

Ah: a mineral horizon enriched with organic matter (<17% organic C by weight).

O: organic horizons developed mainly from mosses, rushes and woody material (>17% organic C or approximately >30% o.m. by weight).

Of: (fibric) the least decomposed organic horizon containing large amounts of organic fibre (von Post 1 – 4).

Om: (mesic) an intermediately decomposed soil horizon with properties intermediate between an Of and Oh (von Post 5 and 6).

Oh: (humic) the most decomposed organic horizon containing only small amounts of well preserved fibre and the major amount of material at an advanced stage of decomposition (von Post 7 – 10).

*ADDITIONAL ADJECTIVE DESCRIPTORS FOR MORS

F — horizons

hypno — feather mosses
sphagno — sphagnum mosses
licheno — lichen species
ericaceo — ericaceous roots
confero — conifer needles
dedicuo — deciduous needles

H — horizons

granulo — granular
amorpho — amorphous
mycelio — fungal hyphae mat
rhizo — rootlet network

example: sphagno - amorpho Fibri HUMIMOR

Note: list is not exhaustive and can be enlarged as required

VARIANTS listed on Table 2.17

Table 2.16 Some chemical characteristics of upland humus forms (from Bernier, 1968)

Chemical Characteristics	MULL	MODER Hi horizon***	MOR H horizon
Organic (%) matter	5-25 (12-18)*	20-60 (40-50)	75-90
C:N ratio	12-28	20-25	20-35
pH (water)	4.0-8.0 (5.0-7.0)	4.0-5.5 higher in calcareous variants	3.0-4.5 exceptionally up to 7.0
Cation exchange capacity (meq/100 g)**	20-40 higher in clayey variants	50-80	75-130
Base saturation (%)	35-100 (60-100)	15-50	10-35

* Figures in parentheses are the most common values.
** Ammonium acetate method.
*** "i" indicates incorporation or intermixing with mineral soil.

Table 2.17 Criteria for distinguishing variants of humus forms*, with codes (from Bernier, 1968)

Texture classes (for mulls only): to stress extremes of texture.		
CL	Clayey:	a high clay content, very sticky when wet.
LO	Loamy:	medium texture.
SA	Sandy:	a high sand content; characterized by a certain rawness and loose consistency.
Moisture classes: to stress prevalent conditions of extreme wetness or dryness.		
HY	Hydric:	in the capillary fringe over a shallow water table, or in seepage sites.
ME	Mesic:	well drained and moderately well drained conditions; mesic conditions are normal for upland humus forms and need not be mentioned.
XE	Xeric:	very dry sites.
Acidity classes:		
		pH (water)
AC	Acid	<5.0
SC	Slightly Acid	5.0-6.0
NE	Neutral	6.0-7.5
CA	Calcareous	>7.5 or effervescence upon treatment with HCl (10%)
Depth classes: to stress extreme thickness or shallowness of the humus profile.		
TK	Thick:	overall thickness >20 cm
TN	Thin:	overall thickness <5 cm

* Not all these criteria need be coded. In general, code only those that depart from conditions normal for a given humus form. For instance, acid need not be mentioned for Mors since most have a pH <4.5.

43. SURFACE SUBSTRATE

An evaluation of surface substrate classifies the ground surface within a plot into various types that create significant differences in micro-environment for plant establishment. An accurate evaluation requires a thorough investigation of the whole plot, and probably a number of small excavations (with a large knife or small shovel), to determine the thickness of LFH horizons and decaying wood, and what substrates underlie moss, liverwort, and lichen communities. Record the evaluation as the percentage of the ground surface covered by each type (the total should equal 100%). Enter 0.0 if a substrate is not present. The applicable surface substrates are defined as follows:

Decaying Wood — consists of fallen trees, large branches on the ground surface, and partially buried stumps with an exposed edge, but does not include freshly fallen material that has not yet begun to decompose. Decaying wood may be covered with mosses, lichens, liverworts, or other plants. However, if an organic layer has developed over the wood, the decaying wood must exceed 10 cm in thickness or the wood should be classed as part of the organic matter type.

Bedrock — consists of exposed consolidated mineral material, not covered by unconsolidated mineral or organic material in excess of 2 cm in thickness. It may have a partial covering of mosses, lichens, liverworts, or other epilithic plants.

Cobbles and Stones — consists of exposed unconsolidated rock fragments greater than 7.5 cm in diameter. These may be covered by mosses, lichens, liverworts, or an organic layer less than 2 cm in thickness.

Mineral Soil — consists of unconsolidated mineral material of variable texture not covered by organic materials. It may have a partial cover of mosses, lichens, and liverworts. It is often associated with cultivation, tree tip-ups, active erosion or deposition, severe fires, trails, or late snow retention areas.

Organic Matter — consists of organic layers which have accumulated on the soil surface and ranges from easily recognizable undecomposed vegetative parts, to humified organic material. The organic layers may overlie mineral soil, cobbles, stones, or bedrock with a minimum organic layer thickness of 2 cm; or they may include thin layers of decaying wood less than 10 cm thick. Areas covered by mats of bunchgrasses should be classed as organic matter because the mats include L horizons. Ah or Ap horizons should be considered as mineral soil. Areas of living grass or forb cover, where mineral soil is visible between stems, should be classed as mineral soil. Large animal droppings are classified as organic matter.

Water — consists of areas of open water, such as streams, puddles, or areas of open water in bogs or fens.

44. PROFILE STATUS

This entry indicates how the soil profile being described relates to the soil unit being developed, or to other existing soil units. Circle one entry only on the Site Description Form.

a. ***Modal*** — site represents the central concept of soil unit.

b. ***Variant*** — soil could represent a new soil, but has limited area.

c. ***Taxadjunct*** — a soil whose properties are outside the range of those specified for a recognized soil but where differences are not significant enough to warrant treatment as a new soil for most interpretations.

d. ***Undecided*** — it is unclear how the soil being described relates to established soil units.

45. PROFILE DEVIATION

Indicate the reasons, if known, why the described soil deviates from the modal concept of the soil unit. If there is no deviation, circle "a" for none. No more than three letters may be circled but up to 20 characters can be entered in free format to explain "Other".

46. SOIL MAPPING UNIT

Circle only one entry on the Site Description Form.

a. ***Series*** — a basic unit of soil classification, composed of soils that are essentially alike in all major profile characteristics except texture of the surface.

b. ***Family*** — a category of soil classification based on soil taxonomy at the subgroup level, particle size, mineralogy, depth to bedrock, reaction, calcareousness, and soil climate.

c. ***Associate*** — a non-taxonomic but cartographic grouping of soils or land segments, which combines related soils into units having similarity in geomorphic position, landform, edaphic, and mechanical properties of soils.

d. ***Association*** — a natural grouping of soil associates based on similarities in climatic or physiographic factors and soil parent materials.

e. ***Catena*** — a non-taxonomic grouping of a sequence of soils of about the same age, derived from similar parent materials, and occurring under similar climatic conditions, but having unlike characteristics because of variations in relief and drainage.

f. ***Complex*** — a mapping unit where two or more defined soil units are so intimately intermixed geographically that it is not practical, because of scale, to cartographically separate them.

g. ***Land system*** — an area of land throughout which there is a recurring pattern of landforms, soils, and vegetation (Lacate, 1969).

h. ***Land type*** — an area of land, on a particular parent material, having a fairly homogenous combination of soil (series) and chronosequence of vegetation (Lacate, 1969).

z. ***Other*** — explain the type of soil mapping unit used in the space provided under "Notes on Site Description" (Item 54).

47. SOIL NAME

Enter (if known) the full name of the soil at the site you are describing, or the soil symbol if no name is given. The name will either already be established from pre-existing work (e.g., in previously mapped areas) or will have to be established. If a new name is to be established, it must be checked against the Provincial Soil Name File to ensure uniqueness (contact the provincial soil correlator). Note that new official soil names must be at least six characters long.

48. ASSOCIATED SOIL

Record here the name of the soil that is closely associated with the one presently being described: for example, the Selish soil (Orthic Gray Luvisol, lithic phase) is associated with the Britton soil (Orthic Gray Luvisol).

49. PROFILE NUMBER

This category is completed when more than one pedon is described for the same soil type in a particular study or project. The number is entered right justified.

50. PROJECT COORDINATOR/SURVEYOR

The project coordinator is the individual who is responsible for supervising the project. The last name should be entered in full; the first name, if indicated, may be abbreviated. The surveyor is the person coding the Site Description Form. Where more than one individual is involved, dashes should be used between their names.

51. AGENCY

Use the appropriate code, from the list below, to identify the organization for whom the data are being collected. Two agencies can be recorded for cooperative projects. Enter the code(s) left justified; the first four spaces are for the first code and the second four spaces are for the second code, if used. For other organizations, use the first letter of the organization category (i.e., "I" for industry) and either two or three letters of the organization name.

Provincial agencies:

- B.C. Ministry of Environment (ME)
  - Fisheries and Wildlife Branches (MEFW)
- B.C. Ministry of Forests (MF)
  - Research Section or Branch — MFRS
  - Range Section or Branch — MFRG
  - Inventory and Planning Branch — MFI
- B.C. Ministry of Agriculture and Fisheries — (MA)
  - Soils and Engineering Branch — MAS
  - Agricultural Land Commission — MALC

Universities:

- University of British Columbia — UBC
- Simon Fraser University — USF
- University of Victoria — UVIC

Federal agencies:

- Agriculture Canada (CA)
  - Vancouver Research Station — CAVA
  - Agassiz Research Station — CAAG
  - Kamloops Research Station — CAKA
- Environment Canada (CE)
  - Lands Directorate — CELD
  - Canadian Forestry Service — CEFS

Industry:

e.g., MacMillan Bloedel Ltd. — IMB
Fletcher-Challenge Ltd. — IFP
CIP (Pacific Logging) — IPL

Consulting Companies:

Denote with "X", followed by the two or three letter initials of the company (e.g., "Arctic Ecosystems Ltd." would be "XAE".)

52. TYPE OF SOIL SAMPLE

This item identifies whether any soil samples were collected for chemical and/or physical laboratory analysis, and whether the whole profile was sampled ("full") or only some horizons were sampled ("partial"). For example, if a B horizon is sampled for pyrophosphate analysis and pH only, then chemical/partial is circled. However, if the whole profile is sampled as a benchmark site, then circle both "chemical/full" and "physical/full". If no sample is taken, do not circle any entry. Soil sampling procedures are discussed at the end of Chapter Three.

53. VEGETATION SAMPLING TECHNIQUE

Describe in free format, the type of statistical or nonstatistical design used for vegetation sampling.

54. NOTES ON SITE DESCRIPTION

Six hundred characters are provided on a separate page of the Site Description Form for recording in free format any additional information not already contained in the previous categories. More detail regarding coded data can be recorded as well. The lines are continuous so that a comment from one line can be continued to the next.

Any information surveyors wish to record for their own use, but which is *not* to be entered into the computor data bank, should be recorded at the bottom or on the back of the form outside the computer codable portion.

CHAPTER 3

SOIL DESCRIPTION

(if continuation then put ? over ADDP(0))

SERIES ☐☐ **FORM** ☐☐☐☐☐

SOIL DESCRIPTION FORM

PROJECT I.D. ______________ PLOT NO ______________ SURVEYOR ______________ PAGE ___ OF ___

0	1							2		3		4		5							6	7									9				10
LEVEL	HORIZON							HORIZON DEPTH cm		HORIZON THICKNESS cm		HORIZON BOUNDARY		COARSE FRAGMENT DESCRIPT							SOIL TEXTURE <2mm	STRUCTURE								MST	CONSIST.				LAB SAMPLE
	discont	horizon	suffixes				subdivision	UPPER	LOWER	MIN	MAX	Dist	Form	By vol	Gravel <7.5 cm		Cobble: 7.5–25cm		Stones >25cm			PRIMARY				SECONDARY				K M D	dry	moist	wet	plast.	
			1	2	3	4										type	-	type		type		GRADE	CLASS	KIND	KIND MOD.	GRADE	CLASS	KIND	KIND MOD.						1
16 a	17							33		41		47		49							64	66								88	89				93
b																																			
c																																			
d																																			
e																																			
f																																			
g																																			
h																																			
i																																			
j																																			

0	11										12									13								14		
LEVEL	COLOUR 1					COLOUR 2					MOTTLES									ROOTS 1				ROOTS 2				HORIZON NOTES		
											AB	SI	CO	COLOUR					BOUND DIS	Ab	Size	Dir	Dist	Ab	Size	Dir	Dist			
	aspect	Hue Number	Hue Letter(s)	Value	Chroma	aspect	Hue Number	Hue Letter(s)	Value	Chroma	X F C M	F M C	F D P	Aspect	Hue Number	Hue Letter(s)	Value	Chroma	S C D	X F P A	V F M C	V H O R	IN EX MX	F P A	V F M C	V H O R	IN EX MX			
16 a	17			25	27	29			37	38	41						53	54		57				62				67		
b																														
c																														
d																														
e																														
f																														
g																														
h																														
i																														
j																														

Province of British Columbia Ministry of Environment and Parks Ministry of Forests and Lands Ministry of Agriculture and Fisheries [illegible] ENV. [illegible]

0	15		16							17	18			19	20							21	22										23			24						
	PH		PORES							HOR. POR.	CLAY FILMS			EFFER	SECONDARY CARBONATE DESCRIPTION							SAL	CONCRETIONS, NODULES AND CASTS										CEMENT			ORGANIC MATERIAL DESCRIPTION						
	reaction	method	Ab.	Size	Ori	Dist	Cont	Mor	Type		Freq.	Thi	Loc	Degr	Cont	Ab.	Size	Shape		Consist			Kind	Ab.	Size	Loc	Shape	Colour					Agent	Degree	Extent	Material Composit			Woody Material		Pyro. Index	von Post Scale
																		Str	Spo	Mst	Dry							Aspect	Hue		Value	Chroma				Kind	Kind	Decom	Hard	Vol		
																													Number	Letter(s)												
			F P A	V F M C	V H Ø R	IN EX MX	CØ DC	S D C	V I T	S M H	X F C M CS	TN MTK TK VTK	1 to 8		1 to 9	X F C M	F M C					X W M S	1 to 11	X F C M	F M C	1 2 3	S Ø I P						1 to 7	W M S I	X D C	1	2		S SH H VH	0 1 2 3 4		
16 a	17	21	23							32	33			39	41							48	49					55			63	65	67			70						78
b																																										
c																																										
d																																										
e																																										
f																																										
g																																										
h																																										
i																																										
j																																										

25

GENERAL COMMENTS ON SOIL CHARACTERISTICS

16
66 115 136 1
16
66 2
16
66 3
16
66 4
16
66 5

27

SCHEMATIC SOIL PROFILE

DEPTH (cm)
10
0
25
50
75
100

26

SOIL TEMPERATURE

Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth
16	23	30	37	44	51	58	65

Chapter Three

SOIL DESCRIPTION

INTRODUCTION

The Soil Description Form is used for recording soil profile features. To achieve consistent use of the form, definitions are provided in this chapter for each parameter on the form. Most definitions are taken from the Land Resource Research Institute's (1983) "Manual for Describing Soils in the Field", with some modifications extracted from other sources (e.g., U.S.D.A. Soil Survey Staff, 1975a).

The Soil Description Series and Form number is the same as that on the Site Description Form and is entered into the boxes in the upper left hand corner. Project I.D. and Plot No. are also the same as on the Site Description Form and are entered in the appropriate places. Surveyor is the name of the individual coding the Soil Description Form.

LEVEL

Alpha characters "a" to "j" are already printed on the form so that the surveyor does not have to repeat the horizon designation. If more than 10 soil horizons are being described, a second soil description form is needed. For each horizon being described on the second form, the "Level" letters a, b, c, etc. should be slashed and replaced by the letters k, l, m, etc. Note that in this situation, an X should be placed over ADDPOO on the second soil description form.

Horizon designations (discont., horizon, suffixes, subdivision) are recorded only once, and are entered into the computer with their corresponding "Level" codes (a, b, c, etc.). For the other two boxes on the form (lower half of the front side, upper half of the back side), only the Level codes are entered into the computer. You *must* ensure that horizon data recorded in these boxes are entered at the appropriate "Level".

It is possible to describe normal horizon data and sample at fixed depth intervals. For example, the following is allowed: Ah (0-4 cm), Ahe (4-10 cm), Bt (10-37 cm), BC (37-52 cm), C (52-105 cm), D1 (0-20 cm), D2 (80-100 cm). D1 and D2 identify samples are taken at fixed depth intervals.

If composite samples consisting of two or more horizons are taken, a new horizon and level must be described. For example, if an Ah (0 to 5 cm) thick and a Bm (5 to 15 cm thick) are sampled together for bulk density determination, a new D1 horizon (0 to 15 cm thick) should be recorded. Only the type of horizon (here D1) and the horizon depths need be noted for such composite horizons.

1. HORIZON DESIGNATION

A soil horizon is a layer of mineral or organic soil, or soil material, approximately parallel to the land surface that has characteristics determined by processes of soil formation. It differs from adjacent horizons in properties such as colour, structure, texture and consistence, and in chemical, biological and mineralogical composition.

The Canadian System of Soil Classification (ECSS, 1987) provides definitions of mineral and organic soil horizons, and definitions of diagnostic horizons and layers for soil classification purposes. Rules concerning horizon and layer designations, such as the use of Roman numerals for lithologic discontinuities, and designations for transitional horizons are also given.

All organic and mineral soil horizon and layer designations should be coded in the allotted spaces: the uppermost (surface) horizon/layer first, followed by all subsequent horizons/layers in order, proceeding downward through the soil profile.

Discontinuity (discont)

Leave blank or enter appropriate Roman numerals (e.g. II, III, IV) right justified if strongly contrasting horizons occur. Note that no entry is needed until a contrasting horizon is encountered, i.e., do not enter "I".

Horizon

Master horizon designations are coded left justified and must be one of the following: O, L, F, H, LF, LH, FL, FH, HL, HF, LFH, LHF, FLH, FHL, HFL, HLF, A, B, C, AB, BA, AC, CA, BC, CB, A&B, B&A, A&C, C&A, B&C, C&B, W, R, ASH, D1 through D20. D1, D2 etc. are non-descriptive layer designations by depth.

Suffixes

Suffix designations are coded left justified and may be one or more of the following, subject to certain restrictions: B, C, CA, CC, CO, E, EJ, F, FJ, G, GJ, GF, H, HF, I, K, M, N, NJ, P, S, SA, T, TJ, U, X, Y, Z. The suffix "I" is used with the H horizon to indicate incorporation or intermixing with mineral soil. A maximum of four suffix codes can be entered, usually in order of dominance.

For example, in coding a Btgj horizon, suffix 1 is T̲ and suffix 2 is G̲ J̲. Note that J by itself is not an allowed suffix.

Subdivision

Leave blank or enter one numeric characteric (e.g., "1", "2"), where appropriate.

2. HORIZON DEPTH

Horizon depth (in centimetres) records the average depths to the upper and lower boundaries of the soil horizon being described. The location from which depths are measured is different for mineral and organic soils. For mineral soils, the top of the uppermost mineral horizon is considered as zero depth. Zero depth for organic soils is the top of the organic material. Organic litter layers (except those that are buried) are listed in descending order of depth; mineral horizons and layers in organic soils are listed in ascending order of depth. The profile may also be described schematically with a sketch of the horizon boundaries on the diagram provided on the back page of the Soil Description Form (see Item 27).

Upper

Upper horizon boundary is the depth at which the horizon being described begins. One digit after the decimal point is allowed and special symbols such as >, <, or + are not permitted. Enter the depth (cm) right justified to the decimal point.

Lower

Lower horizon boundary is the depth at which the horizon being described ends. Coding rules described under "Upper Horizon Boundary" apply. The value of the Lower Horizon Boundary for the lowest horizon in the soil pit usually will be the depth of the pit. Thus, if a pit is 105 cm in depth, the boundary information for a BC horizon may be 95.0 cm — 105.0 cm. This does not imply that the BC horizon necessarily stops at 105 cm, but rather that it is only known to exist to that depth.

Note that the depth of the "Lower Horizon Boundary" is also the depth of the "Upper Horizon Boundary" of the next underlying horizon.

3. HORIZON THICKNESS

Thickness is an actual measure of the *minimum* (min) and *maximum* (max) thickness in centimetres of the soil horizon being described. For example, a soil horizon may have an average thickness of 10 cm, with a thickness range of 2 cm minimum and 13 cm maximum. Enter the numeric values right justified; note that no decimals or other special characters are permitted.

4. HORIZON BOUNDARY

The lower boundary of each horizon is described by indicating its *distinctness* and *form*. The distinctness of a horizon boundary depends partly on the degree of contrast with the adjacent lower horizon and partly on the thickness of any transition zone between them.

Distinctness (Dist)

Distinctness is described in terms of the thickness of the transition between two adjacent horizons as follows:

Distinctness Codes		*Abruptness in Vertical Change*
N	None	-
D	Diffuse	>15 cm
G	Gradual	5-15 cm
C	Clear	2-5 cm
A	Abrupt	<2 cm

Form

Form is described in terms of the shape of the boundary between two adjacent horizons as follows:

Form Codes		*Irregularities of Horizon Surface*
S	Smooth	Horizon surface is nearly a plane
W	Wavy	Horizon surface has pockets that are wider than deep
I	Irregular	Horizon surface has pockets that are deeper than wide
B	Broken	Some parts are unconnected. At least one horizon is discontinuous.

5. COARSE FRAGMENT DESCRIPTION

Coarse fragments (>2 mm diameter) are described by recording the size, dominant type, and estimated volume of each class in each horizon. The total coarse fragment volume can also be recorded for each horizon under "% by volume". Coarse fragments are defined as rock fragments, therefore, fragments of "pans" or concretions are not considered. Enter percent by volume right justified. If no coarse fragments are present, enter the number "0" right justified. A blank (no value entered) indicates that no estimate of coarse fragments was made.

Size Classes	Size Range	
	*Types R, S, A: diameter	*Type T: length
Gravel	<7.5 cm	<15 cm
Cobbles	7.5–25 cm	15–38 cm
Stones[1]	>25 cm	>38 cm

[1] includes boulders.

* Dominant Fragment *Type* Codes:

R — Rounded
S — Sub-rounded and subangular
A — Angular
T — Thin, flat

6. SOIL TEXTURE

Soil texture is defined in terms of the size distribution of primary mineral particles (2 mm dia. or less) as determined by sieve or sedimentation analysis, or field estimation. Where field determinations differ from laboratory results, the field entries on the form should be changed to reflect the laboratory analyses. The *basic* textural classes are indicated in Figure 3.1, in terms of percent clay (less than 0.002 mm diam.) and sand (0.05 to 2.0 mm diam.). The texture codes are indicated in the textural triangle and should be entered on the Soil Description Form left justified. Alternatively, more specific textural classes can be entered as indicated in the following table.

Code	*Soil Textural Classes:*
S	*Sand* — contains 85% or more sand; the percentage of silt, plus 1.5 times the percentage of clay, does not exceed 15.
CS	Coarse sand — 25% or more very coarse and coarse sand, and less than 50% of any other one grade of sand.
MS	Medium sand — 25% or more very coarse, coarse, and medium sand, and less than 50% fine or very fine sand.
FS	Fine sand — 50% or more fine sand, or less than 25% very coarse, coarse and medium sand and less than 50% very fine sand.

VFS	Very fine sand — 50% or more very fine sand.
LS	*Loamy Sand* — contains at the upper limit 85-90% sand, and the percentage of silt plus 1.5 times the percentage of clay is not less than 15; contains at the lower limit 70-85% sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.
LCS	Loamy coarse sand — as for CS.
LMS	Loamy medium sand — as for MS.
LFS	Loamy fine sand — as for FS.
LVFS	Loamy very fine sand — as for VFS.
SL	*Sandy Loam* — contains either 20% clay or less, with the percentage of silt plus twice the percentage of clay exceeding 30, and 52% or more sand; or less than 7% clay, less than 50% silt, and 43-52% sand.
CSL	Coarse sandy loam — as for CS.
MSL	Medium sandy loam — 30% or more very coarse, coarse, and medium sand, (but less than 25% very coarse sand), and less than 30% very fine or fine sand.
FSL	Fine sandy loam — 30% or more fine sand and less than 30% very fine sand, or 15-30% very coarse, coarse, and medium sand; or more than 40% fine and very fine sand, at least half of which is fine sand, and less than 15% very coarse, coarse and medium sand.
VFSL	Very fine sandy loam — 30% or more very fine sand, or more than 40% fine and very fine sand, at least half of which is very fine sand, and less than 15% is very coarse, coarse, and medium sand.
L	*Loam* — contains 7-27% clay, 28-50% silt, and less than 52% sand.
SIL	*Silt Loam* — contains 50% or more silt and 12-27% clay, or 50-80% silt and less than 12% clay.
SI	*Silt* — contains 80% or more silt and less than 12% clay.
SCL	*Sandy Clay Loam* — contains 20-35% clay, less than 28% silt, and 45% or more sand.
CL	*Clay Loam* — contains 27-40% clay and 20-45% sand.
SICL	*Silty Clay Loam* — contains 27-40% clay and less than 20% sand.
SC	*Sandy Clay* — contains 35% or more clay and 45% or more sand.
SIC	*Silty Clay* — contains 40% or more clay and 40% or more silt.
C	*Clay* — contains 40% or more clay, less than 45% sand, and less than 40% silt.
HC	*Heavy Clay* — contains more than 60% clay.

If necessary, the sand and clay sizes can be further subdivided to refine the soil texture classes as follows (or in some other way):

Code	*Name of separate*	*Diameter (mm)*
VCS	Very coarse sand	2.0 — 1.0
CS	Coarse sand	1.0 — 0.5
MS	Medium sand	0.5 — 0.25
FS	Fine sand	0.25 — 0.10
VFS	Very fine sand	0.10 — 0.05
SI	Silt	0.05 — 0.002
C	Clay	<0.002
FC	Fine clay	<0.0002

The textural modifier "mucky" can be recorded under "Horizon Notes" for the affected horizons. Mucky refers to horizons containing 15-30% organic matter (9-17% organic carbon by volume). Note that the modifiers "gravelly" and "very gravelly" can be determined directly from the "coarse fragment description" and thus do not have to be recorded.

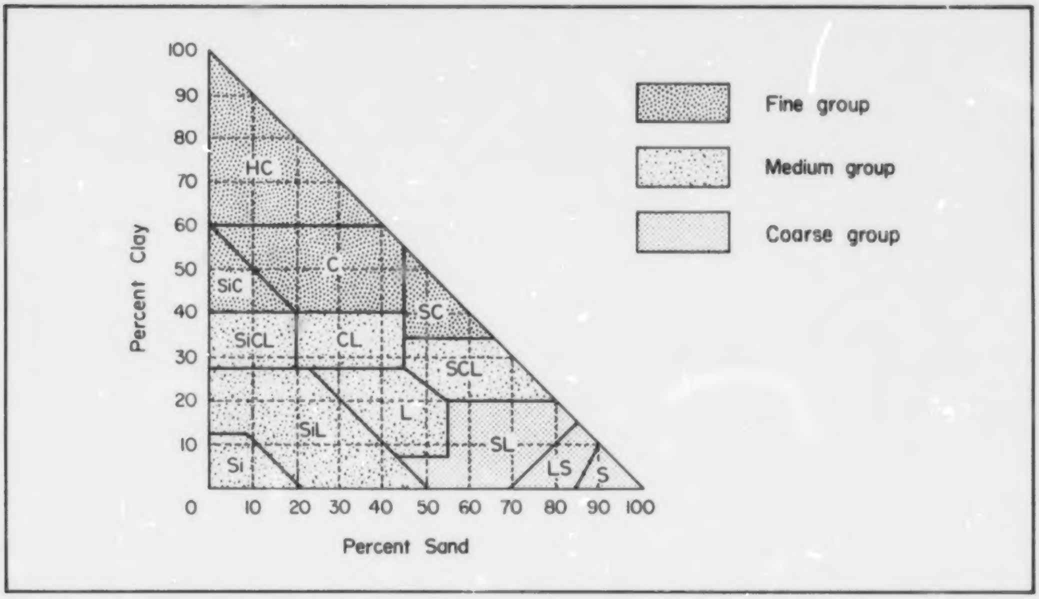


Figure 3.1 Soil textural triangle

The relative proportion of fine fraction particles (sand, silt and clay) can be estimated through "feel". Sand can always be felt as individual grains, but silt and clay generally cannot. Dry silt feels floury while wet silt is slippery or soapy, but not sticky. Dry clay forms hard lumps, is very sticky when wet, and plastic when moist.

Most soils are a mixture of sand, silt and clay, so the graininess, slipperiness, or stickiness varies depending upon how much of each particle size is present. As the amount of clay increases, soil particles bind together more strongly, form stronger casts, and longer, stronger worms. As sand and silt increase, the soil binding strength decreases, and only weak to moderately strong casts and worms can be formed.

The field determination of soil texture is subjective and can only be accomplished consistently with training and experience. The following field tests are provided to assist in the field determinations. They are also outlined in Figure 3.2.

Graininess Test: Rub the soil between your fingers. If sand is present, it will feel "grainy". Determine whether sand comprises more or less than 50% of the sample.

Moist Cast Test: Compress some moist soil by clenching it in your hand. If the soil holds together (i.e., forms a "cast"), then test the durability of the cast by tossing it from hand to hand. The more durable it is, the more clay is present.

Stickiness Test: Wet the soil thoroughly and compress it between thumb and forefinger. Determine degree of stickiness by noting how strongly the soil adheres to the thumb and forefinger upon the release of pressure, and how much it stretches. Stickiness increases with clay content.

Worm Test: Roll some moist soil between the palms of your hands to form the longest, thinnest worm possible. The more clay present, the longer, thinner and more durable the worm will be.

Taste Test: Work a small amount of soil between your front teeth. Silt particles are distinguished as fine "grittiness", unlike sand which is distinguished as individual grains (i.e., graininess). Clay has no grittiness.

Well-decomposed organic matter (humus) imparts silt-like properties to the soil. It feels floury when dry and slippery when moist, but not sticky and not plastic. However, when subjected to the taste test, it feels non-gritty. It is generally very dark in colour when moist or wet, and stains the hands brown or black. Humus-enriched soils often occur in wet sites and in grasslands. Humus is not used as a determinant of soil texture; an estimate of the silt content of humus-enriched mineral soils should be reduced accordingly. "Organic" soil samples are those that contain more than 30% organic matter (17% organic carbon). Soil texture is not determined on organic samples (see Item 24 for organic material description).

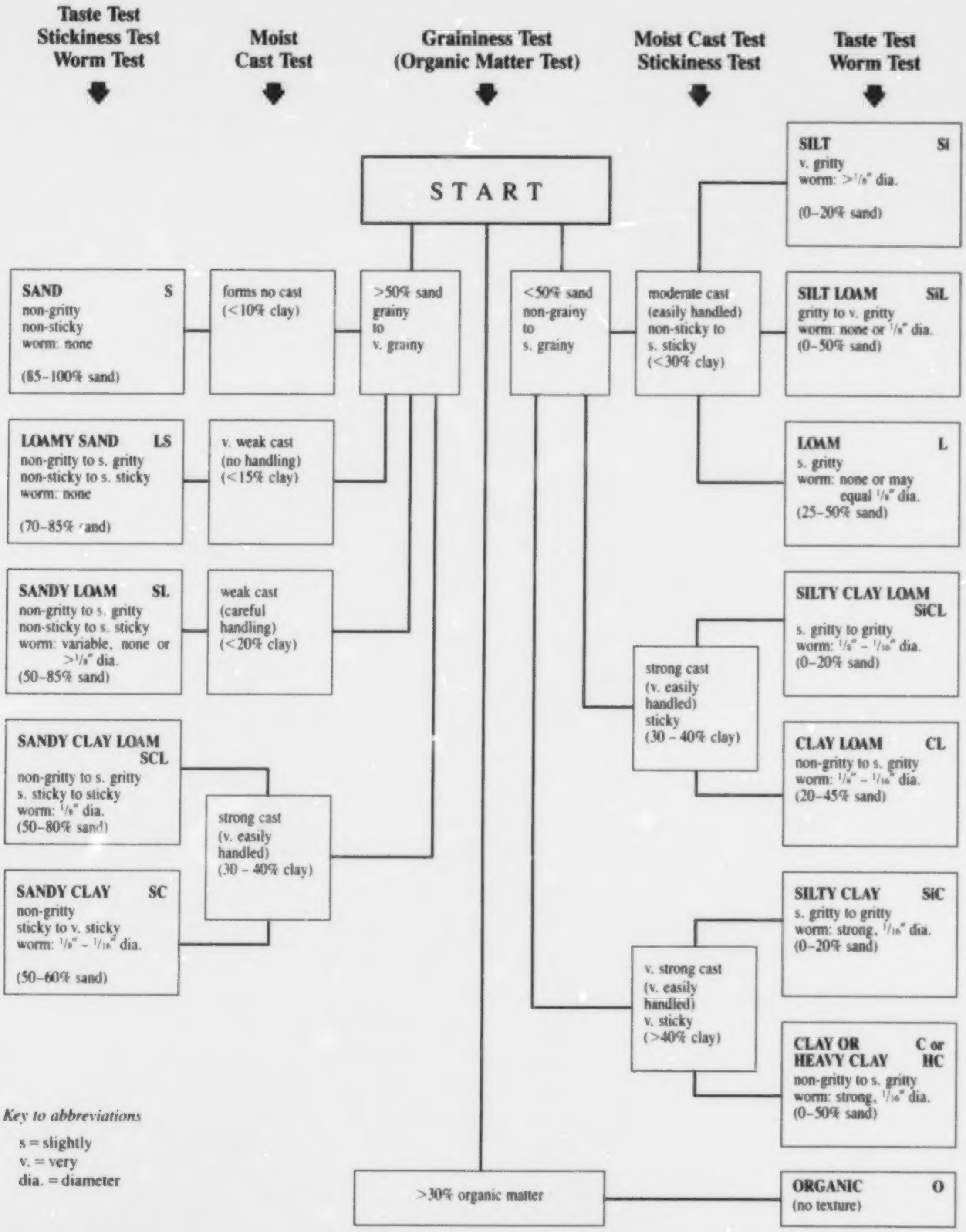

Taste Test
Stickiness Test
Worm Test
Moist
Cast Test
Graininess Test
(Organic Matter Test)
Moist Cast Test
Stickiness Test
Taste Test
Worm Test
START
SILT Si
v. gritty
worm: >1/8" dia.
(0–20% sand)
SAND S
non-gritty
non-sticky
worm: none
(85–100% sand)
forms no cast
(<10% clay)
>50% sand
grainy
to
v. grainy
<50% sand
non-grainy
to
s. grainy
moderate cast
(easily handled)
non-sticky to
s. sticky
(<30% clay)
SILT LOAM SiL
gritty to v. gritty
worm: none or 1/8" dia.
(0–50% sand)
LOAMY SAND LS
non-gritty to s. gritty
non-sticky to s. sticky
worm: none
(70–85% sand)
v. weak cast
(no handling)
(<15% clay)
LOAM L
s. gritty
worm: none or may equal 1/8" dia.
(25–50% sand)
SANDY LOAM SL
non-gritty to s. gritty
non-sticky to s. sticky
worm: variable, none or >1/8" dia.
(50–85% sand)
weak cast
(careful handling)
(<20% clay)
SILTY CLAY LOAM SiCL
s. gritty to gritty
worm: 1/8" – 1/16" dia.
(0–20% sand)
strong cast
(v. easily handled)
sticky
(30 – 40% clay)
SANDY CLAY LOAM SCL
non-gritty to s. gritty
s. sticky to sticky
worm: 1/8" dia.
(50–80% sand)
CLAY LOAM CL
non-gritty to s. gritty
worm: 1/8" – 1/16" dia.
(20–45% sand)
strong cast
(v. easily handled)
(30 – 40% clay)
SANDY CLAY SC
non-gritty
sticky to v. sticky
worm: 1/8" – 1/16" dia.
(50–60% sand)
SILTY CLAY SiC
s. gritty to gritty
worm: strong, 1/16" dia.
(0–20% sand)
v. strong cast
(v. easily handled)
v. sticky
(>40% clay)
CLAY OR HEAVY CLAY C or HC
non-gritty to s. gritty
worm: strong, 1/16" dia.
(0–50% sand)
Key to abbreviations
s = slightly
v. = very
dia. = diameter
>30% organic matter
ORGANIC O
(no texture)

Figure 3.2 Field determination of soil texture

7. STRUCTURE

Soil structure refers to the aggregation of primary soil particles into compound particles that are separated from adjoining aggregates by persistent surfaces of weakness. Soil structure is classified in terms of *grade* (distinctness, durability), *class* (size), and *kind* (shape). Both *primary* and *secondary* structure are determined when soils have structures consisting initially of large peds but break down to smaller peds, or when structures are one form in place and another when disturbed. If a soil has only one structural form, it is referred to as primary. When soil materials have structures that are other than pedological in origin, a 'kind' modifier is indicated. Codes to be used on the Soil Description Form and definitions follow.

A natural soil aggregate is called a *ped* and should not be confused with a *clod* (a transient mass formed by disturbances such as plowing), a *fragment* (formed when the soil cracks or breaks through the soil matrix), or a *concretion* (formed by local concentration of compounds that cement the individual soil grains together). Breakage into pieces larger than soil grains, but without some orderly shape and size, and without surfaces that infer persistence, should not be confused with soil structure.

Grade

Grade is the degree of distinctness of aggregation of soil particles. It expresses the differential between cohesion within the aggregates (peds) and adhesion between aggregates. Field determination assesses the ease with which the soil separates into discrete persistent peds, and also the durability of the peds when they are separated from the soil volume.

Grade varies with the moisture content of the soil. When soils are described in the field, structure is determined at the existing soil moisture state, which must be specified for each horizon. If representative soil descriptions are prepared, structure is described for the soil moisture content *most common* for the soil, and that state is specified. Changes in structure under the varying moisture conditions can be recorded under "Notes".

Definitions of the three basic structure grades follow. Codes are provided for these and for two additional intermediate grades which occur. Enter the appropriate code left justified on the soil desscription form.

Structure Grade Codes

W	weak
WM	weak to moderate
M	moderate
MS	moderate to strong
S	strong

Weak Structure (W). Peds are either indistinct and barely evident in place, or observable in place but incompletely separated from adjacent peds. When disturbed, the soil material separates into a mixture of only a few entire peds, many broken peds, and much unaggregated material.

Moderate Structure (M). Peds are moderately durable, and are evident but not distinct in the undisturbed soil. When disturbed, the soil material parts into a mixture of many well-formed, entire peds, some broken peds, and little unaggregated material. The peds may be handled without breaking, and they part from adjoining peds to reveal nearly entire surfaces that have properties distinct from those caused by fracturing.

Strong Structure (S). Peds are durable and evident in the undisturbed soil, adhere weakly to one another, withstand displacement and separate cleanly when the soil is disturbed. When removed, the soil material separates mainly into entire peds on handling. Surfaces of unbroken peds have distinctive properties, compared to surfaces that result from fracturing.

Compound Structure. Some soil horizons have structure consisting of small peds which are separated by persistent planes of weakness, yet hold together to form discrete bodies recognizable as larger peds. The larger peds are referred to as *primary structure* and the smaller ones as *secondary structure*. The grade, class and kind should be described for each if both occur. If only one structural form occurs, it is considered to be primary structure.

Table 3.1 Types, kinds and classes of soil structure

Type	Kind	Class	Size[1] (mm)
Blocklike — soil particles arranged around a point and bounded by flat or rounded surfaces	*Angular blocky* (ABK): peds bounded by flattened, rectangular faces intersecting at relatively sharp angles	VF: very fine angular blocky	<5
		F: fine angular blocky	5-10
		M: medium angular blocky	10-20
		C: coarse angular blocky	20-50
		VC: very coarse angular blocky	>50
	Subangular blocky (SBK): peds bounded by slightly rounded, subrectangular faces with vertices[2] of their intersections mostly subrounded	VF: very fine subangular blocky	<5
		F: fine subangular blocky	5-10
		M: medium subangular blockly	10-20
		C: coarse subangular blocky	20-50
		VC: very coarse subangular blocky	>50
	Granular (GR): Spheroidal peds bounded by curved or very irregular faces that do not adjoin those of adjacent peds	VF: very fine granular	<1
		F: fine granular	1-2
		M: medium granular	2-5
		C: coarse granular	5-10
		VC: very coarse granular	>10
Platelike — soil particles arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces	*Platy* (PL): Peds flat or platelike; horizontal planes more or less well developed	VF: very fine platy	<1
		F: fine platy	1-2
		M: medium platy	2-5
		C: coarse platy	5-10
		VC: very coarse platy	>10
Prismlike — soil particles arranged around a vertical axis and bounded by relatively flat vertical surfaces	*Prismatic* (PR): Vertical faces of peds well defined and vertices[2] angular (edges sharp); prism tops essentially flat	VF: very fine prismatic	<10
		F: fine prismatic	10-20
		M: medium prismatic	20-50
		C: coarse prismatic	50-100
		VC: very coarse prismatic	>100
	Columnar (COL): Vertical edges near top of columns not sharp (vertices[2] subrounded); column tops flat, rounded, or irregular	VF: very fine columnar	<10
		F: fine columnar	10-20
		M: medium columnar	20-50
		C: coarse columnar	50-100
		VC: very coarse columnar	>100
Structureless — no observable aggregation of primary particles or no definite orderly arrangement around natural lines of weakness	*Single grained* (SGR):	loose, incoherent mass of individual primary particles, as in sands	
	Massive (MA):	amorphous; a coherent mass showing no evidence of any distinct arrangement of soil particles; separates into clusters of particles, not peds	
Cloddy (CDY): not a structure; used to indicate the condition of some ploughed surfaces; grade, class, and shape too varied to be described in standard terms.			

[1] The size limits refer to measurements in the *smallest dimension* of platy, prismatic, and columnar peds and to the *largest* of the nearly equal dimensions of blocky and granular peds.

[2] Definition of vertex (plural, vertices): the intersection of two planes of a geometrical figure.

Class

The recognized structure classes (size ranges) vary with the kind of structure, as indicated in Table 3.1 and illustrated in Figure 3.3. Measurement should be made in the smallest dimension for platy peds (vertical dimension or plate thickness), and prismatic and columnar peds (horizontal dimension); and in the largest dimension for blocky and granular peds. Table 3.1 contains the five basic size classes for each kind of structure. Where more than one class occurs in a single horizon, record the dominant class. Intermediate classes can be recorded, and codes for these are included below. Enter the codes left justified on the Soil Description Form.

Structure Class Codes

VF	very fine	M	medium
VFF	very fine to fine	MC	medium to coarse
F	fine	C	coarse
FM	fine to medium	VC	very coarse

Kind

The shape of peds is designated as the *type* of soil structure, but is not recorded. The type, in turn, is sub-divided into *kinds* of structure, on the basis of the character of the ped faces and edges of the aggregates. The four main structure types and their sub-division into eight kinds of soil structure are listed in Table 3.1 and illustrated in Figure 3.3. When more than one kind of primary structure is present (such as granular plus subangular blocky), record the dominant under primary structure, and the subordinate in horizon notes. Enter the appropriate codes (from Table 3.1) left justified on the Soil Description Form.

Kind Modifier

Soil horizons sometimes have structures that are not pedological in origin. This is a modification of the kind of structure (kind modifier) and generally indicates a structure inherited from the parent material. The modifier *Pseudo* (coded *PS*) is used for these structural traits; for example, pseudo-platy or pseudo-angular blocky.

8. MOISTURE (MST)

Indicate the field moisture state of each horizon at the time of description by entering either "D" for dry, "M" for moist, or "W" for wet.

Dry State. Soil is considered to be dry when soil-water is held at a tension of at least 15 bars (atmospheres), the approximate permanent wilting point. The term *air dry* means, literally, as dry as soil can be when in equilibrium with the air. Though this varies with relative humidity and air temperature, the term is useful for describing a state at which soil water is held at tensions much greater than 15 bars, and which can be easily attained in the field. Figure 3.4 illustrates this relationship. Field clues to the recognition of water content at 15 bars tension or higher depend mainly on plasticity. If a durable "wire" 3 mm in diameter can not be rolled, the soil is dry; this test is only applicable to plastic (i.e., clayey) materials. Medium textured soils break into "powder" when dry.

Moist State. The water content in moist soil consists of that held between tensions of about $^{1}/_{3}$ bar and 15 bars. These values approximately equate with field capacity and permanent wilting percentage, respectively. For plastic materials, a durable "wire" at least 3 mm in diameter can be rolled if the soil is moist. Moist soils in the drier part of the range become perceptably darker with additional moistening.

Wet State. Soil is wet when it contains water that can be removed by tensions of less than about $^{1}/_{3}$ bar, (i.e., "free water" subject to drainage under the force of gravity). Field clues for identifying the wet soil water state depend primarily on visual evidence of free water or identifiable water films. If water is visible in pores, or if water films give a shiny appearance to ped surfaces or primary particles, the soil material is wet. When wet soils of any texture are squeezed, a wet outline is left on the hand.

Note: The previous field clues are generalizations for commonly occurring mineral soils. These can vary due to many specific factors, such as mineralogy, organic matter content, and temperature.

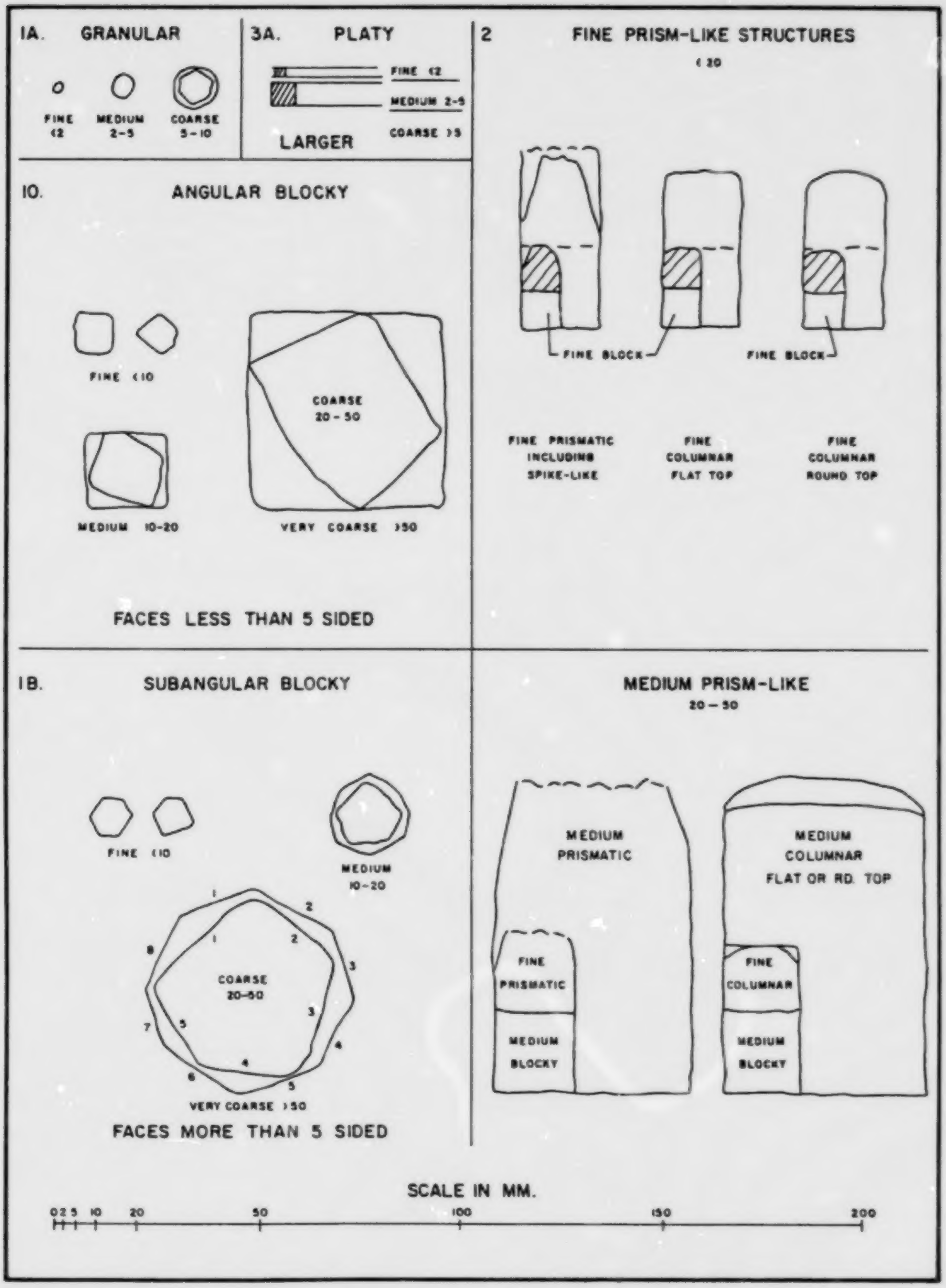

1A. GRANULAR
FINE <2
MEDIUM 2-5
COARSE 5-10
3A. PLATY
FINE <2
MEDIUM 2-5
COARSE >5
LARGER
2 FINE PRISM-LIKE STRUCTURES
<20
FINE BLOCK
FINE BLOCK
FINE PRISMATIC INCLUDING SPIKE-LIKE
FINE COLUMNAR FLAT TOP
FINE COLUMNAR ROUND TOP
1O. ANGULAR BLOCKY
FINE <10
MEDIUM 10-20
COARSE 20-50
VERY COARSE >50
FACES LESS THAN 5 SIDED
1B. SUBANGULAR BLOCKY
FINE <10
MEDIUM 10-20
COARSE 20-50
VERY COARSE >50
1 2 3 4 5 6 7 8
1 2 3 4 5
FACES MORE THAN 5 SIDED
MEDIUM PRISM-LIKE
20-50
MEDIUM PRISMATIC
FINE PRISMATIC
MEDIUM BLOCKY
MEDIUM COLUMNAR FLAT OR RD. TOP
FINE COLUMNAR
MEDIUM BLOCKY
SCALE IN MM.
0 2 5 10 20 50 100 150 200

Figure 3.3 Diagrammatic representation of soil structure

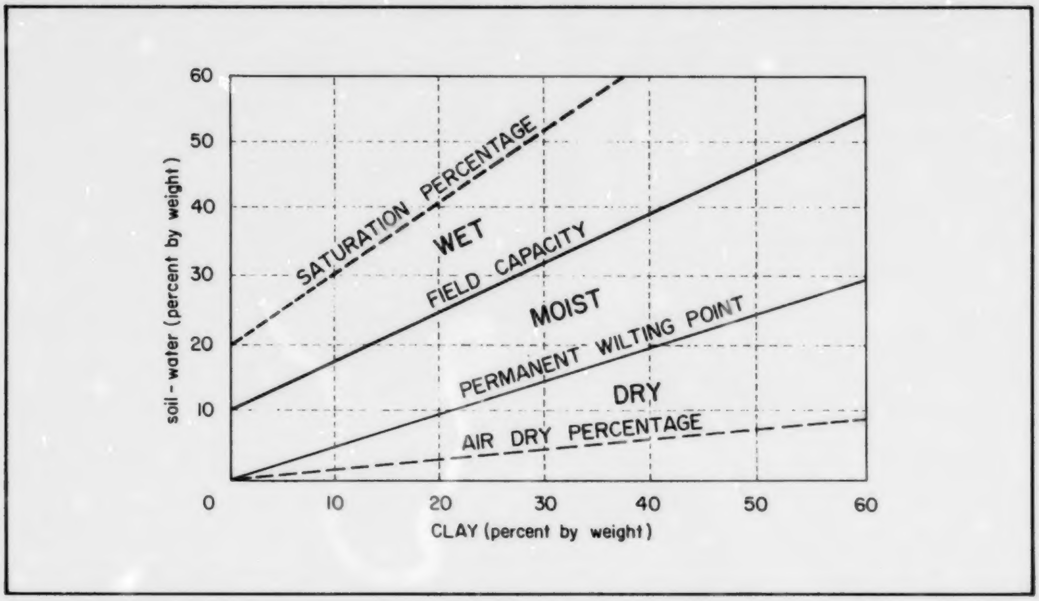


Figure 3.4 Soil moisture content vs. clay content, as an aid in the field determination of soil moisture content

9. CONSISTENCE

The consistence of mineral soil refers to its resistance to deformation and rupture (soil strength), and to its degree of internal cohesion and adhesion. All mineral soil material has consistence irrespective of whether the mass is large or small, in a natural condition or greatly disturbed, aggregated or structureless, or wet, moist, or dry.

Soil consistence should be evaluated under standard conditions of water content, specimen size, and force application. Meaningful comparison between soils (or horizons) is otherwise difficult. Soil consistence is highly dependent on the soilwater content. Terminology includes separate terms for decription at three standard moisture contents: dry, moist, and wet (defined in the previous section). Plasticity is always described in the wet state. For some soils, describing the consistence at each state is unnecessary. For example, the consistence when dry may be irrelevant in descriptions of soils that are never dry. Since classification of wet consistence (stickiness) and plasticity requires that soil samples be crushed and water added, these two evaluations may be carried out for all mineral horizons.

Dry and Moist Consistence

Dry and moist soil consistence is determined under field conditions by estimating the soil strength (resistance to crushing of an unconfined volume of soil). Since soil strength often depends on the size of the test specimen, its shape, and the way force is applied, a uniform system of testing must be used if results are to be comparable.

If the soil is not loose (single-grained), remove a ped or soil fragment from the profile and trim it to form an equidimensional standard test specimen with sides 2.5 cm long and two roughly parallel bearing surfaces. Apply stress slowly, squeezing the specimen between thumb and forefinger until failure is just perceptible. The amount of force required to produce failure is the criterion for moist and dry consistence classes. Estimation of the force exerted can be refined with practice in compressing standarized mechanical devices, or by exerting force on specimens of the same origin as those which have failed from crushing or breaking under weights of known force.

Code	*Dry Consistence*
1	Loose — the soil material is non-coherent (falls apart into individual grains).
2	Soft — the soil material is weakly coherent and fragile, and breaks to a powder or individual grains under very slight pressure; the specimen fails under less than 0.8 kg of force (very gentle pressure).

3	Slightly hard — the soil material is weakly resistant to pressure and easily crushes between the thumb and forefinger; the specimen withstands 0.8 kg of force but fails under 4 kg of force (4 kg of force corresponds to firm pressure between the extended thumb and forefinger of many people, but is significantly less than the maximum force that can be exerted slowly).
4	Hard — the soil material is moderately resistant to pressure; it can be crushed in the hands without difficulty, but considerable pressure is necessary to crush it between the thumb and forefinger; the specimen withstands 4 kg of force but fails under 8 kg of force (8 kg of force is near the maximum force that can be exerted between the extended thumb and forefinger of most people).
5	Very hard — the soil material is very resistant to pressure; it can be crushed in the hands only with difficulty, and is not crushable between thumb and forefinger; the specimen withstands 8 kg of force but fails under 16 kg of force (16 kg of force corresponds approximately to the force that can be applied slowly by compression between two hands; compression means "squeezing together" and does not mean shearing or slamming the soil material).
6	Extremely hard — the soil material is extremely resistant to pressure and cannot be crushed in the hands; the specimen withstands 16 kg of force but fails under 80 kg of force (80 kg of force is near the pressure of full body weight for many people, applied between the foot and a hard surface).
7	Rigid — the soil material cannot be crushed except by extreme pressure; the specimen withstands 80 kg of force.

Code	*Moist Consistence*
1	Loose — The soil material is non-coherent (falls apart into individual grains).
2	Very friable — the soil material is crushed under very gentle pressure, and coheres when pressed together; the specimen fails under less than 0.8 kg of force (very gentle pressure).
3	Friable — the soil material is easily crushed under gentle to moderate pressure between the thumb and forefinger and coheres when pressed together; the specimen withstands 0.8 kg of force, but fails under 2 kg of force (gentle pressure).
4	Firm — the soil material is crushed under moderate pressure between the thumb and forefinger, but resistance is distinctly noticeable; the specimen withstands 2 kg of force but fails under 4 kg of force (4 kg of force corresponds to firm pressure between the extended thumb and forefinger of many people, but it is considerably less than the maximum force that can be exerted slowly).
5	Very firm — the soil material can be crushed between the thumb and forefinger, but strong pressure is required; the specimen withstands 4 kg of force but fails under 8 kg of force (8 kg of force is near the maximum force that can be exerted between the extended thumb and forefinger for many people).
6	Extremely firm — the soil material cannot be crushed between the thumb and forefinger: indurated horizons are examples.

Wet Consistence

Wet consistence, referred to as "stickiness", is determined at moisture levels that are at, or slightly above, field capacity. Stickiness is the degree of adhesion to other objects or materials. It changes as soil structure is destroyed and as the soil moisture content changes. Stickiness in the field is determined on the fine earth fraction (particles passing through a #10 sieve, 2 mm in diameter). The sample should be crushed in the hand, water added if necessary to bring it to the wet state, and then thoroughly puddled. The puddled soil should then be pressed between the thumb and forefinger, and its adherence to the digits noted. To adjust water content, the sample should be worked in the hand to remove water, or have water added to achieve the maximum stickiness.

Code	*Wet Consistence (stickiness)*
1	Nonsticky — after the release of pressure, practically no soil material adheres to either the thumb or finger.
2	Slightly sticky — after pressure has been applied, the soil material adheres to both the thumb and finger, but comes off one or the other rather cleanly. The soil is not appreciably stretched when the digits are separated.

3	Sticky — after pressure has been applied, the soil material adheres strongly to both the thumb and forefinger and tends to stretch somewhat and pull apart rather than pulling free from either digit.
4	Very sticky — after pressure has been applied, the soil material adheres strongly to both the thumb and forefinger and is decidedly stretched when they are separated, then breaks and remains on both digits.

Plasticity (Plast)

Plasticity is the ability to change shape continuously under the influence of an applied stress, and to retain the new shape after removal of the stress. The maximum expression of the property should be reported. Crush the sample in your hand and add water, if necessary, to bring the fine earth fraction of the sample to the wet state. Thoroughly puddle the material and adjust the moisture content by rolling the sample in your hand to reduce moisture, or by adding more water.

Moisture content at maximum plasticity is above the point where a roll of material 4 mm in diameter crumbles, but below the water content at which stickiness, if it is exhibited, exceeds slightly sticky. Roll the material between the palms of your hands or on a flat surface, and use the minimum thickness of a roll 4 cm long that can support its own mass when dangled from the thumb and forefinger as the criterion of maximum plasticity classes.

Code	*Plasticity (ability to change shape)*
1	Nonplastic — a roll 4 cm long and 4 mm thick cannot be formed.
2	Slightly plastic — a roll 4 cm long and 4 mm thick can be formed but cannot support its own weight.
3	Plastic — a roll 4 cm long and 2 mm thick can be formed but cannot support its own weight.
4	Very Plastic — a roll 4 cm long and 2 mm thick can support its own weight.

10. LABORATORY SAMPLE

This space is for recording whether a soil sample is collected for laboratory analysis. Code "1" if a sample is taken.

If the samples are on the basis of depth intervals rather than horizons, enter them below the standard soil horizon codes (see Item 1). Label the samples as "D1", "D2", etc., and give the corresponding depth intervals (e.g., 0-15 cm, 15-30 cm).

11. COLOUR 1 AND COLOUR 2

Although colour has little direct influence on the functioning of soil, it is a useful property for soil identification and appraisal, because other properties that are not as easily observed can be inferred from it. The importance of soil colour as a diagnostic property is greatest within the confines of a limited geographic area. Reliable correlations may be determined, for example, between soil colour and soil organic matter content, reducing (wet) conditions, or materials high in iron. Note that some soils, exhibit colour directly inherited from the parent rock.

Determination of Soil Colour

Soil colour is determined by comparison with standard colour charts. The most common charts are those in the Munsell colour system and consist of nearly 200 different standard colour chips, systematically arranged on seven cards according to Munsell notations. An additional card, for the bluish and greenish hues of gleyed soils, is also available.

The Munsell system uses three elements of colour — hue, value, and chroma — to make up a specific colour notation. The symbol for *hue* is the letter abbreviation of the colour of the rainbow (R for red, YR for yellow-red, Y for yellow) preceeded by numbers from 0 to 10. Within each letter range, the hue becomes more yellow and less red as the preceeding number increases. Hue is a measure of the chromatic composition of light that reaches the eye, and the value notation is a measure of the amount of light that reaches the eye under standard lighting conditions. The notation for *value* indicates the degree of lightness and consists of numbers from 0 (for absolute black) to 10 (for absolute white).

The notation for *chroma* indicates the relative purity of colour strength (degree of dilution by neutral gray of the same value) and consists of numbers from 0 for neutral gray to 8, the strongest expression of colour used for soils.

The notation for a specific colour should be recorded on the Soil Description Form in the order of hue, value/chroma. For example, "pale brown" is designated 10YR 6/3. The hue number is entered right justified to the decimal point, and hue letter(s) left justified. Note that decimals exist for value and chroma.

Each colour chip represents only one point in a continuous range of hue, value, and chroma and all possible colour graduations between any two adjacent chips are possible. Rarely will soil colour match any one chip perfectly. In addition, none of the soil colour charts have chips for chromas of 5 or 7; and charts for hues of 2.5YR, 7.5YR, and 2.5Y do not include chips for colours having chroma of 3. These colours are encountered in some soils and can be estimated by interpolation between adjacent chips. Intermediate hues, values, and chromas may be expressed with the use of decimals. For example, the notation for a colour midway between 2.5YR 5/6 and 5YR 6/8 is 3.75YR 5.5/7. Precision in field determination of colour is often not great enough to justify some interpolations and intervals between colours should not be divided more finely than into halves. Expression of colour should usually be to the nearest colour chip.

Light Conditions for Measuring Colour. The quality and intensity of the incident light on a sample affect the light reflected from the sample to the eye, as does the moisture content and roughness of the sample surface. Since the visual impression of colour from the standard colour chips is accurate only under standard light conditions, it is important that (1) light quality is near enough to white light that the reflected light is not unduly affected by colour from the light source itself, and (2) the amount of light is adequate for visual distinctions among the colour chips. Precise colour determinations should not, therefore, be attempted early in the morning or in the evening when the sun is low in the sky and light reaching the sample is reddish.

Dominant Colour. The dominant colour ("Colour 1" on the soil form) is that which occupies the greatest volume in a soil horizon. In detailed descriptions, record colours of both dry and moist soil if possible. A dry soil can be moistened (not saturated) or a moist soil brought into a room to dry. Local accumulations of carbonates and cementing agents, as well as clay skins, concretions, and mottles commonly differ in colour from the surrounding matrix, and are described elsewhere on the form. Usually at least one colour should be recorded for each horizon. A secondary colour may be described for each horizon under "Colour 2". Enter additional information necessary for adequate colour description under "Horizon Notes". Some soil orders require that colours be determined for taxonomic classification (see ECSS, 1987).

Colour Aspect. The colour of a soil varies with its moisture content and physical state, so it is essential that these parameters are recorded with each colour notation by using the codes provided. The "dry" state at which soil colour should be determined is "air-dry", the state attained where further drying causes no further increases in colour value. Most soils within the drier half of the "moist" range become perceptibly darker with moistening. The change of colour value in the wetter half of the "moist" range is less, and is negligible for many soils. Consequently, the colour of soil when it is moist should be determined on "very moist" soil (near field capacity; no surface moisture films visible). Differences between colour of the soil material in place and that of a crushed mass, or between ped faces and interiors are noted by the appropriate aspect code right justified. Soils having dark ped surfaces and light coloured interiors are not adequately described by noting only crushed colours.

Colour Aspects for Mineral Soils

Code	*Aspect*	*Description*
1	Matrix moist	Matrix is the main soil constituent or material that encloses other soil features, for example, peds. This colour aspect is reserved for structureless soils or weakly structured soils whose peds crumble upon handling.
2	Matrix dry	
3	Exped moist	Colour of ped surfaces in soils with moderately durable peds which may be broken open and examined.
4	Exped dry	
5	Inped moist	Dominant colour of ped interiors in soils with moderately durable peds that may be broken open and examined.
6	Inped dry	
7	Crushed moist	Soil material is crushed and mixed. Surface of the sample is smoothed to reduce irregularities that affect colour.
8	Crush dry	

Colour Aspects for Organic Soils

Code	*Aspect*	*Description*
9	Natural wet/reduced*	Colour of broken surface of unaltered wet material.
10	Natural wet/oxidized**	
11	Pressed wet/reduced*	Colour of wet material after being squeezed between thumb and forefinger to remove free water.
12	Pressed wet/oxidized**	
13	Rubbed wet/oxidized	Colour of wet material after rubbing between thumb and forefinger approximately 10 times, squeezed to form a clod, and broken to expose the interior. Rubbing causes oxidation, therefore no reduced colours are noted.
14	Rubbed dry	Same procedure as above (under 13) but air-dried.

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* Reduced = Colour of freshly dug, wet material, as it comes out of the pit.

** Oxidized = Colour of material allowed to stand until no further colour change occurs. The sample may remain wet if change is rapid; if change is slow and drying occurs, re-wet as necessary.

12. MOTTLES

Mottles are spots or blotches of different colour or shades of colour interspersed in the dominant soil colour. This general definition could be applied to any of the secondary colours in multi-coloured soil material, such as in "mottled appearance", but for description of soil horizons the term is used in a more restrictive manner. Mottling commonly results from reduction caused by prolonged periods of wetness but can also result from other causes, such as various kinds of staining under oxidizing conditions. The description of mottling merely records its presence without comment as to its' origin. The term does not apply to the colours of identifiable bodies or surfaces, such as concretions, nodules, ped coatings, clay films, surface staining on pebbles, in-filling of old root channels or animal burrows, or local accumulations of carbonates or cementing agents. These colours, recorded elsewhere on the form, or under "Notes", are not termed "mottles" in the description.

Mottling in soils is described by recording abundance, size, contrast, boundary distinctness, and colour. Colour is estimated using the standard Munsell colour notation procedures previously outlined. Space for only one mottle description is provided on the soil form; additional information may be recorded under "Horizon Notes".

Abundance (AB)

The quantity of mottles is indicated by abundance classes based on the percent of the exposed soil surface that is occupied by mottles of a given kind, as follows:

Code	*Abundance*	*% of Exposed Surface*
X	None	0
F	Few	<2
C	Common	2-20
M	any	>20

Size (SI)

Mottle sizes refer to their approximate dimensions as seen on a plane surface. Mottle length determines the size class when it is not more than 3 times the width; the width is the determinant if the mottle is long and narrow. The three relative size classes are as follows:

Code	*Size Class*	*Diameter*
F	Fine	<5 mm
M	Medium	5-15 mm
C	Coarse	>15 mm

Contrast (CO)

Contrast of mottles refers to the degree of visual distinction between mottles of a given kind and the "matrix". When colours of both mottles and matrix are recorded, the degree of contrast is relatively evident from the notations. However, judgement of contrast in the field is useful, for it is often not a simple matter of comparing one colour with another, but a visual impression of the prominence of one colour against a background of one or several colours. Table 3.2 presents numerical definitions for three mottle contrast classes in terms of various combinations of Munsell colour units of hue, value, and chroma. Faint, distinct, and prominent mottles are defined as follows:

Code

F *Faint:* Evident only on close examination. Faint mottles commonly have the same hue as the colour to which they are compared and differ by no more than 1 unit of chroma or 2 units of value. Some faint mottles of similar but low chroma and value can differ by 2.5 units of hue.

D *Distinct:* Readily seen, but contrast only moderately with the colour to which they are compared. Distinct mottles commonly have the same hue as the colour to which they are compared, but differ by 2 to 4 units of chroma or 3 to 4 units of value; or differ from the colour to which they are compared by 2.5 units of hue but by no more than 1 unit of chroma or 2 units of value.

P *Prominent:* Contrast strongly with the colour to which they are compared. Prominent mottles are commonly the most obvious colour feature in a soil. Prominent mottles that have medium chroma and value commonly differ from the colour to which they are compared by at least 5 units of hue if chroma and value are the same; at least 4 units of value or chroma if the hue is the same; or at least 1 unit of chroma or 2 units of value if hue differs by 2.5 units.

Table 3.2 Determination of mottle contrast by dissimilarity from matrix in Munsell units

		Difference from the matrix in	
	Hue	**Value**	**Chroma**
	pages	units	units
Faint	0	≤2	≤1 or
	1	0	0
Distinct	0	3-4	2-4 or
	1	≤2	≤1
Prominent	2+	0	0 or
	0	≥4	≥4 or
	1	≥2	≥1

Boundary Distinctness (Bound. Dis.)

Mottle boundaries (the transition from mottle to matrix) can be described as sharp, clear, or diffuse. These terms are defined as follows:

Code	*Boundary*	*Description*
S	Sharp	As a Knife edge
C	Clear	<2 mm wide
D	Diffuse	>2 mm wide

13. ROOTS 1 AND ROOTS 2

Roots in a soil indicate the relationships between soil properties and the habits and adaptations of plants. Their absence can be significant and should be recorded because it may reflect unfavourable conditions in the soil. Roots should be described by noting their abundance, size, orientation, and distribution. Since roots of varying sizes are commonly present in a horizon, space is provided for recording the most abundant size (under "Roots 1") and a secondary size of importance (under "Roots 2").

Abundance (Ab)

Abundance classes are defined in terms of numbers of roots per square decimetre by size class. To determine abundance, a cross-section at right angles to the principal orientation of the roots is selected for examination. The abundance classes are taken from LRRI (1983) and reflect substantial changes in definition from those in the first edition of this manual. Since the new classes do not recognize "very few", it is not defined below.

		Number per square decimetre by size class		
Code	*Abundance*	*Very Fine/Fine*	*Medium*	*Coarse*
X	None	0	0	0
V	Very Few	N/A	N/A	N/A
F	Few	<10	<1	<1
P	Plentiful	10-100	1-10	1-5
A	Abundant	>100	>10	>5

Size

Code	*Size Class*	*Root Diameter (mm)*
V	Very Fine	<1 mm
F	Fine	1-2
M	Medium	2-5
C	Coarse	>5

Orientation (Ori)

Code	*Orientation*	*Definition*
V	Vertical	Roots orientated mainly vertically
H	Horizontal	Roots orientated mainly horizontally
O	Oblique	Roots orientated mainly obliquely
R	Random	Roots orientated in all directions (no dominant plane)

Distribution (Dist)

In soils that have structure, roots are described as either occurring within peds (inped), or along ped surfaces (exped). In structureless soils, or soils with weak structure (having much unaggregated material), most roots are found within the soil matrix.

Code	*Distribution*	*Definition*
IN	Inped	Roots found predominantly within peds
EX	Exped	Roots found predominantly along ped surfaces
MX	Matrix	In structureless soils, or soils with weak structure; roots found within the soil matrix

14. HORIZON NOTES

Additional information about individual soil horizons can be entered here in free format. General comments on the entire soil profile can be recorded under Item 25, on the back side of the Soil Description Form.

15. pH

Soil reaction, the hydrogen ion activity (pH) of soil, receives special emphasis in soil classification, not only because it is directly important, but also because other soil properties less easily determined (such as base saturation) may be inferred from it. Within a limited range of soil properties such as may occur in a small soil survey project, soil reaction provides a very useful indication of such attributes as base status, degree of weathering, amount of leaching, reactions of some plant nutrients, and various toxicities for plants.

Record pH by noting the method of field measurement and the determined values. Enter the values to one decimal place. The method code should be recorded right justified.

Method Code	*Method*
1	Bromothymol blue
2	Cresol red
3	Hellige-Truog
4	Lamotte-Morgan
5	pH meter (1:1 H_20)
6	pH meter (0.1 M $CaCl_2$)
7	Phenol red
8	Soiltex
9	Thymol blue
10	pHydrion

16. PORES

The pore space (volume) in mineral soils generally ranges between one-third and two-thirds of the total soil volume; the average is probably about one-half. Pores in soils are due to the aggregation of primary particles, the irregularly rounded and angular shapes of mineral particles, root channels, and disturbance by insects, worms, and other burrowing animals.

Soil pore space can be considered as a network of voids extending in all directions. The voids hold liquids and gases and regulate their movement, contain most of the living organisms in the soil, and provide space for roots to develop. When the soil is saturated, the movement of water is very closely related to the continuity of even a few voids larger than 0.1 mm. The general nature of the pores in a horizon can often be inferred from descriptions of texture, structure, consistence, root distribution, and perhaps other properties that are routinely described. Additional direct information about pores may also be useful and can be recorded.

There is no practical field method for describing the intricate network of voids characteristic of all soils. Field descriptions emphasize those pores that can be seen without strong magnification (those due to the action of roots, animals, and expanding gases), and unusually arranged void patterns.

Soil pores are described in terms of (1) abundance, (2) size, (3) orientation, (4) distribution, (5) continuity, (6) morphology, and (7) type. Although a variety of pores with varying character may be present in a horizon, space is provided on the soil form for recording only the most common case. Note that the pore type often determines what other terms will be used to describe the pores.

When comparing soil profile descriptions, it should be remembered that soil characteristics vary seasonally and under different field conditions. Soil pores in particular exhibit noticeable changes as soil moisture content varies, especially if swelling clay minerals are present.

Abundance (Ab)

Abundance classes are defined in terms of numbers of pores per square decimetre by size class. For tubular pores only, select a cross-section for examination at right angles to the principal orientation of the pores. The abundance classes are taken from L.R.R.I. (1983) and reflect substantial changes in the definitions from those in the first edition of this manual. Since the new classes do not recognize "very few", it is not defined below.

		Number per square decimetre by size class			
Code	*Abundance*	*Very Fine*	*Fine*	*Medium*	*Coarse*
X	None	0	0	0	0
V	Very Few	N/A	N/A	N/A	N/A
F	Few	<25	<10	<1	<1
P	Plentiful	25-200	10-50	1-5	1-3
A	Abundant	>200	>50	>5	>3

Size

Five pore size classes are used to describe tubular and vesicular pores. Measurements are based on the smallest dimension.

Code	*Size*	*Measurement in Small Dimension (mm)*
V	Very Fine	<0.5
F	Fine	0.5-2
M	Medium	2-5
C	Coarse	>5

Orientation (Ori)

The following orientation classes apply only to tubular pores:

Code	*Orientation*	*Definition*
V	Vertical	Orientation is mainly vertical
H	Horizontal	Orientation is mainly horizontal
O	Oblique	Orientation is mainly oblique
R	Random	Orientation is in all directions

Distribution (Dist)

In soils that have structure, pores are described as either occurring within peds (inped), or following ped surfaces (exped). In structureless soils, or soils with weak structure (having much unaggregated material), most pores are found within the soil matrix.

Code	*Distribution*	*Definition*
IN	Inped	Pores are dominantly within peds.
EX	Exped	Pores are dominantly along ped surfaces.
MX	Matrix	Pores are within the soil matrix.

Continuity (Cont)

Continuity of tubular pores (only) indicates whether continuous passages (larger than 0.1 mm diam.) are available for liquid and gas movement. The terms used are as follows:

Code	*Continuity Class*	*Definition*
CO	Continuous	Individual pores extend throughout the horizon and provide continuous passages.
DC	Discontinuous	Individual pores extend only part way through the horizon and are interrupted so that continuous passages are few or absent.

Morphology (Mor)

The morphology of tubular pores (only) is described as branched or unbranched, and open-ended or closed, in the following combinations:

Code	*Morphology*	*Definition*
S	Simple	Tubular pores are not branched; pores are open at least at the upper end or at one horizontal end.
D	Dendritic	Tubular pores are branched; pores are open at least at the upper end or at one horizontal end.
C	Closed	All ends of tubular pores (branched or unbranched) are sealed from access to air and water by organic or organo-mineral material or clay flows.

Types of Pores (Type)

Pore shape is described as one of three types.

Code	*Pore Type*	*Definition*
V	Vesicular	Pores are roughly spherical or elliptical in shape, not appreciably elongated in any direction; they are enclosed and not continuous.
I	Interstitial	Pores are irregular in shape and bounded by curved or angular surfaces of mineral grains or peds, or both.
T	Tubular	Pores are approximately cylindrical in shape and are greatly elongated in one direction.

17. HORIZON POROSITY (Hor. Por.)

Horizon porosity is an estimate of total pore volume and reflects the combined effects of soil structure and packing density, i.e., the arrangement of solid particles. The three porosity classes are defined in Table 3.3.

Table 3.3 Guide to the description of porosity classes[1]

Code	Porosity Class	Total Pore Volume Range	Bulk Density Range (g/cm^3)	Description
S	Slightly porous	<40%	>1.6	Closely packed structureless soil material; highly compacted material.
M	Moderately porous	40–60%	1.1–1.6	Horizons with weak to moderate structure and moderately close packing; closely packed soils with large, well-developed peds.
H	Highly porous	>60%	<1.1	Horizons that are loosely packed, and/or very well structured with small peds.

[1] In organic soils, total porosity ranges from approximately 80% in humic horizons to more than 90% in fibric horizons.

Total pore volume is somewhat independent of pore size and pore continuity, therefore total porosity should not be used in isolation to predict water-holding capacity or a soil's potential to transmit water internally (perviousness). For example, sandy soils may have low total pore volume because of the close packing of sand grains, yet they usually transmit water rapidly as a result of the high proportion of large (continuous) pores, and exhibit low water-holding capacity because of the low proportion of small pores.

Total porosity can be estimated in the field in general terms. If bulk density is known, total porosity is implied, as illustrated in the following equation:

$$\%\ \text{Pore Space} = 100 - \frac{\text{Bulk Density}}{\text{Particle Density}} \times 100$$

Although the density of individual soil minerals may vary considerably, the particle density for most mineral soils usually lies between 2.60 and 2.75 g/cm^3. For general calculations, an average particle density of 2.65 g/cm^3 is assumed.

18. CLAY FILMS

Clay films (skins) are accumulations of oriented clay translocated from another part of the soil. These coatings are unlike the adjacent matrix and may cover surfaces of soil peds, mineral grains, rock fragments, and/or soil pores.

Clay films are described by recording the frequency of occurrence, estimated (or measured) thickness, and their location in relation to other morphological features. Descriptions of other clay film properties, such as colour, texture, and distinctness (contrast with matrix), may be needed to adequately characterize the morphology of some soils, but space for these has not been provided on the Soil Description Form: such features can be recorded as special notes. Although more than one type of clay film can occur in a given horizon, space is only provided to describe the most common type. Description of the secondary types can be recorded in "Horizon Notes".

Frequency Classes (Freq)

The frequency of clay film occurrence refers to the percentage of the specified kind of surface (location) that is coated by clay films in the soil horizon. Frequency does not refer to the distribution or continuity of clay films on individual surfaces or to their total volume. The same classes used for surface coatings are used to describe the amount of "bridges" between sand grains. The amount is judged on the basis of the proportion of grains that are joined to adjacent grains by bridges of clay at contact points. Table 3.4 provides the description and codes for frequency classes. Enter the appropriate codes left justified on the data form.

Table 3.4 Guide to the description of clay film frequency classes

Code	Frequency Class	% of Specific Surface Covered	Description
X	None	0	No clay films present.
F	Few	<2	Clay films cover less than 2% of the total area of the specified surface(s). Patches of film are identifiable, but their frequency is so low that the significance of their presence may be nil or doubtful.
C	Common	2–20	Clay films cover 2–20% of the total area of the specified surface(s).
M	Many	20–80	Clay films cover 20-80% of the total area of the specified surface(s). They may occur as discrete patches or as a continuous network.
CS	Continuous	>80	Clay films cover more than 80% of the total area of the specified surface(s). Patches of these surfaces may be free of clay films, but the films are essentially continuous.

Thickness Classes (Thi)

Thickness of clay films often varies appreciably within a distance of a few millimetres. In such cases, estimate the average thickness and report the appropriate thickness class. If appreciable variations in thickness occur over distances of a centimetre or more and are judged to be significant, report the most appropriate thickness class and note the variations as special notes. Table 3.5 provides the descriptions and codes for thickness classes. Enter the appropriate codes left justified.

Table 3.5 Guide to the description of clay film thickness classes

Code	Thickness Class	mm	Description
TN	Thin	<0.05	Hand lens is needed for identification; visible in cross section with 10X lens but not to the unaided eye. If present, fine sand grains protrude through the film or are only thinly coated and are readily apparent.
MTK	Moderately Thick	0.05–0.5	Clay films are visible in cross-section to the unaided eye. Fine sand grains are enveloped by the film or their outlines are indistinct. Film surfaces are relatively smooth.
TK	Thick	0.5–1.0	Clay films and their broken edges are readily visible without magnification. Film surfaces are smooth.
VTK	Very Thick	>1.0	Clay films are a striking feature of the morphology.

Location (Loc)

Location classes identify areas of the soil where clay films have most commonly accumulated. Deviations can be recorded as special notes. The following codes (and definitions) should be used.

Code	*Location*
1	In pores and/or channels only
2	On ped faces (unspecified)
3	In many pores/channels and on some vertical and horizontal ped faces
4	In all pores/channels and on all vertical and horizontal ped faces
5	Visible bridges between sand grains
6	Coatings on sand grains
7	On lower surfaces of coarse fragments
8	On upper surfaces of coarse fragments

19. EFFERVESCENCE (EFFER)

Effervescence is the bubbling, hissing, or foaming that occurs when a chemical reagent is added to a sample of soil. It is due mainly to the presence of free carbonates and manganese oxides, or sometimes organic matter, and is recorded by noting the relative degree of effervescence. It is assumed that the chemical reagent is 10% HCl — if another reagent is used, such as $H_2 0_2$ or a different strength of HCl, it must be specified in "Horizon Notes". Enter the appropriate codes left justified on the Soil Description Form.

Code	*Class*	*Degree of Effervescence*
X	None	No evidence of effervescence
VW	Very Weak	Few bubbles. (Note: insure that the crackling sound is from reaction rather than absorption of liquid, compare with water.)
W	Weak	Bubbles readily observed
M	Moderate	Bubbles form low foam
S	Strong	Bubbles form thick foam

20. SECONDARY CARBONATE DESCRIPTION

Describe accumulations of secondary carbonates (of calcium and/or magnesium) for each horizon by noting the continuity and distribution, abundance, size, shape, and consistence of the carbonate enriched areas. Carbonate colours may be recorded as special notes. The appropriate codes and classes follow.

Continuity and Distribution of Carbonate Areas (Cont)

Code	*Continuous Distribution*
1	Homogeneous, not banded
2	Nonhomogeneous, not banded
3	Homogeneous, banded
4	Streaked, banded

Code	*Discontinuous Distribution*
(parts of the horizon are free of carbonates)	
5	Streaked
6	Spotted
7	Streaked and spotted
8	Nodular
9	Banded (tops and/or bottoms of coarse fragments)

Abundance of Carbonate Areas (Ab)

Code	*Abundance Class*	*Volume of horizon (%)*
X	None	0
F	Few	<2
C	Common	2-20
M	Many	>20

Size of Carbonate Areas (Size)

Code	*Size Class*	*Width or Diameter* (or thickness if banded)
F	Fine	<5 mm
M	Medium	5-15 mm
C	Coarse	>15 mm

Shape of Streaked and/or Spotted Carbonate Areas (Shape)

Code	*Shape of Streaks*	*Code*	*Shape of Spots*
V	Vertical	C	Rounded
H	Horizontal	O	Oblong
R	Random	I	Irregular

Consistence of Carbonate Areas (Consist)

Consistence of carbonate area definitions are the same as those described in the soil consistence section (Item 9). In many instances, carbonate accumulations are too small for consistence to be determined. The appropriate dry and moist consistence codes follow.

Code	*Moist Consistence*	*Code*	*Dry Consistence*
1	Loose	1	Loose
2	Very Friable	2	Soft
3	Friable	3	Slightly Hard
4	Firm	4	Hard
5	Very Firm	5	Very Hard
6	Extremely Firm	6	Extremely Hard
		7	Rigid

21. SALINITY (SAL)

The presence of soluble salts in the soil and parent material is an important characteristic for evaluating biological and non-biological uses. Salts are commonly visible as crystals or veins, or surface crusts but sometimes are not evident morphologically. Inhibited crop growth and the presence of salt-tolerant plants are frequently good indicators of excessive salts in the soil.

Salinity can only be determined in the field with special equipment; therefore, soil samples are usually analyzed in the laboratory. The electrical conductivity (E.C.) of a saturation extract, expressed in millisiemens (mS) per cm and corrected to a standard temperature of 25°C, is the standard measure of salinity. Electrical conductivity is related to the amount of salts more soluble than gypsum (calcium sulfate). Soluble salts in soils are usually various sodium and potassium salts, magnesium chloride, magnesium sulfate, and calcium chloride. Table 3.6 defines the salinity classes and indicates the appropriate codes.

Table 3.6 Guide to the description of salinity classes

Code	Salinity Class	E.C. (mS/cm)	Salt Content (by wt.)	Description
X	Non saline	<4	<0.15%	Soils unaffected by salt.
W	Weakly saline	4–8	0.15–0.35%	Soils slightly affected by salt or alkali (sodium). Growth of sensitive crops is inhibited but that of salt-tolerant crops may not be.
M	Moderately saline	8–15	0.35–0.65%	Soils moderately affected by salt or alkali. Crop growth is inhibited and no crop does well.
S	Strongly saline	>15	>0.65%	Soils strongly affected by salt or alkali. Only a few kinds of plants survive.

22. CONCRETIONS, NODULES, AND CASTS

Concretions, nodules, and casts are identifiable bodies within the soil matrix that differ from the surrounding material because of the concentration of some constituent or a change in fabric. These discrete bodies are sufficiently strong and distinct to be removed from the soil matrix as intact entities. They are either cemented into relatively strong units, or are uncemented but coherent units that separate from the matrix along clearly defined boundaries. They range in composition from material dominantly like that of the matrix, to concentrations of nearly pure chemical compounds.

Although "concretions" and "nodules" are used interchangeably in this section, the term concretion is often restricted to concentrations having concentric fabric, that is, layers clearly accumulated around a point, line, or plane. The term "nodule" is reserved for concentrations lacking orderly internal organization. If distinguishable, this difference should be recorded as a special note. Casts are units of biological origin, exhibiting a form imposed from outside (i.e., from the digestive tracts of worms or insects).

Describe concretions, nodules, and casts by noting their kind, abundance, size, location, shape, and colour. Other attributes that are significant, such as distinctness (contrast with the matrix), strength (consistence), or differences between the surface and interior of units may be recorded as special notes. Since space on the Soil Description Form is not allocated for recording more than one type, the most common or pedologically significant type should be described in detail and other types noted in the 'General Comments' section.

Kind

If known, the composition of the units is described. For some, the chemical composition cannot be determined with certainty in the field and laboratory analysis is required. Any kind may be described in more detail under special notes. Enter the appropriate code right justified on the Soil Description Form.

Code	*Kind*	*Notes*
1	Durinodes	Lab analysis required. Weakly cemented to indurated concretions; brittle when wet. Cement is SiO_2.
2	Gypsum	Lab analysis required.
3	Salts	Lab analysis required; more soluble than gypsum.
4	Lime	Lab analysis required.
5	Lime silica	Lab analysis required.
6	Oxides	Magnetic or non-magnetic oxides of iron, aluminum, and/or manganese.
7	Pedotubules	Natural voids (channels) filled with soil material showing tubular form.
8	Worms Casts	Excretions consisting of mechanically inseparable complexes of colloidal humus and mineral soil.
9	Insect Casts	Excretions consisting almost exclusively of organic matter.
10	Others	Specify in special notes.
11	Unspecified	

Abundance (Ab)

Abundance refers to the relative volume of a horizon occupied by the specified kind of concretion, nodule or cast. The codes and classes follow.

Code	*Abundance Class*	*Volume of Horizon (%)*
X	None	0
F	Few	<2
C	Common	2-20
M	Many	>20

Size

The size classes describe the size of the specified kind of concretion, nodule or cast. The size class limits apply to the dimension of the shortest axis of the unit and can be thought of as sieve sizes.

Code	*Size Class*	*Dimension of the Shortest Axis*
F	Fine	<5 mm
M	Medium	5-15 mm
C	Coarse	>15 mm

Location (Loc)

Three general location classes are defined. The locations may be described in more detail under special notes.

Code	*Location Class*
1	Around root channels
2	Local concentrations
3	Throughout matrix

Shape

Shapes of concretions, nodules or casts range from those that approach regular geometric forms to others that are extremely irregular. The appropriate codes and classes follow.

Code	*Shape Class*	*Description*
S	Spherical	Bodies that are approximately equidimensional, have few sharp corners, and are somewhat regular in form.
O	Oblong	Bodies that are somewhat oblong, cylindrical, or tubular in form; one dimension is much greater than the other two.
I	Irregular	Bodies that are characterized by branches, or are convoluted or mycellial forms.
P	Plate-like	Bodies that are shaped somewhat like a plate; one dimension is very much smaller than the other two. The term "plate-like" is used to avoid confusion with "platy" structure.

Colour

Record the surface colour of the concretions, nodules or casts using the Munsell color system (see Item 11). If interior colors are significantly different, they should be recorded as special notes.

23. CEMENTATION (CEMENT)

Cementation refers to a brittle, hard soil consistence caused by cementing substances other than clay. It is reported by noting the cementing agent (usually requiring laboratory analysis), and the degree and continuity of cementation.

Cemented layers or horizons are commonly referred to as "pans" and can affect soil taxonomy. They usually have been formed genetically as part of the present soil forming and weathering cycle (but sometimes may be relics of earlier cycles of weathering). Their presence is significant to many soil uses because they may prevent or restrict water and root penetration. These restricting characteristics are often a reliable way of identifying their presence.

Cementing Agent (Agent)

The probable cementing agent may be indicated in the field, but confirmation by lab analysis is usually required. The usual cementing agents and their codes follow.

Code	*Cementing Agent*	*Code*	*Cementing Agent*
1	Humus-aluminum	4	Silica (iron)
2	Iron	5	Lime and silica
3	Lime	6	Other: recorded as special note
		7	Unspecified

Degree of Cementation (Degree)

The degree of cementation is evaluated by determining if a wet test specimen, 2.5 cm^3 in size, can be crushed by a stated force. An air-dry test specimen is *immersed in water for one hour* and if it slakes (crumbles), it is considered to be *uncemented*. If the specimen does not slake, its resistance to crushing is determined while it is wet and the appropriate category of cementation reported.

Code	*Commencing Agent*	*Definition*
W	Weakly cemented	The wet specimen can be crushed between the thumb and forefinger. Specimen fails under 4 kg of force.
M	Moderately cemented	The wet specimen is brittle and hard, and cannot be crushed between thumb and forefinger, but can be broken in the hands. Specimen withstands 4 kg of force but fails under 8 kg of force.
S	Strongly cemented	The wet specimen is brittle and too hard to be broken in the hands, but is easily broken with a hammer. Specimen withstands 8 kg of force but fails under 80 kg of force.
I	Indurated	The wet specimen is brittle and so strongly cemented that a very sharp blow with a hammer is required to break it. Specimen withstands 80 kg of force.

Extent

Continuity of cementation is be generally characterized according to the following categories based on horizontal extent:

Code	*Continuity of Cementation*
X	Cementation not present
C	Continuous over a distance of at least 1 m
D	Discontinuous over a distance of 1 m; includes horizons in which only cemented fragments occur

24. ORGANIC MATERIAL DESCRIPTION

"Organic material" in this section refers to non-living organic material and the microscopic living organisms that are intimately associated with it. The application of this section is restricted to organic horizons of both mineral and organic soils (i.e., L, F, H and O horizons). The organic material forming these horizons is described, as follows:

Material Composition

The most common kind(s) of recognizable organic material is noted for each horizon. The occurrence of woody material and its volumetric percentage in each horizon is recorded separately. The two most common kinds of organic material (other than wood fragments) present are coded as Kind 1 (most common) and Kind 2 (second most common). If significant, more precise volumetric percentages of the specified materials can be recorded as special notes. The kinds of organic material and their codes follow.

Code	*Kind of Organic Material*
1	Angiosperm broad leaves
2	Coniferous needles
3	Sphagnum moss
4	Mosses other than Sphagnum species
5	Sedges, reeds, and associated plants
6	Herbaceous fragments
7	Coprogenous earth: contains at least 50% by volume of fecal pellets less than 0.5 mm in diameter
8	Other: Specify under "Horizon Notes"

State of Decomposition (Decom.)

The fiber content of organic material provides a measure of the degree of decomposition. The Rubbed Fiber Content (%) characterizes the state of decomposition of each organic horizon *as a whole*. Field determination is described by McKeague (1978) and requires the use of a modified hypodermic syringe, paper towelling, a 6 mm wide spatula, a 100 mesh sieve 8 cm in diameter, and running water. The test results are classified as follows:

Code	*Decomposition Class*	*Rubbed Fiber (%)*
N	None	100
S	Slight	40-99
M	Moderate	10-39
H	High	<10

Woody Material

The average hardness of woody material and the volume of wood fragments in each organic horizon is estimated in the field. The size of woody materials, if significant, can be recorded as special notes. Estimate woody material hardness using wet specimens no larger than 10 cm in length. Enter the appropriate codes left justified on the Soil Description Form.

Woody Material Hardness Code	*Class*	*Definition*
S	Soft	The wet specimen can be crushed easily between the thumb and forefinger using only moderate pressure.
SH	Slightly hard	The wet specimen can be crushed between thumb and forefinger using considerable pressure.
H	Hard	The wet specimen cannot be crushed between thumb and forefinger but can be broken in the hands.
VH	Very hard	The wet specimen cannot be broken in the hands.

Woody Material Volume Code	*Woody Material Volume Class*
0	None
1	<10% by volume
2	10-20% by volume
3	20-50% by volume
4	>50% by volume

Pyrophosphate Index (Pyro. Index)

The pyrophosphate index is a colour test that provides another method for estimating the degree of decomposition of organic material. It is based on the colour of chromatographic paper dipped in a solution of organic material extracted with sodium pyrophosphate. The index is the difference between the Munsell colour value and chroma of the paper — positive and negative values are both reported as positive. The procedure is described in "The Canadian System of Soil Classification" (ECSS, 1987, p. 29) and requires the use of the following special equipment: sodium pyrophosphate, small plastic screw-topped container, syringe, tweezers, and chromatographic paper.

von Post Scale of Decomposition (von Post Scale)

The von Post scale is a field assessment of the decomposition of organic material. A sample of wet organic material is squeezed in the hand, and the colour of the solution that is pressed out between the fingers, the nature of the plant remains, and the proportion of original sample remaining are noted. Definitions of the decomposition classes and their codes follow. Enter the appropriate code right justified on the Soil Description Form.

Code	*Decomposition Class Description*
1	Undecomposed; plant structures are unaltered; squeezing in the hand yields only clear water that is either colourless or light yellow brown.
2	Almost undecomposed; plant structures are distinct; squeezing yields almost clear water coloured light yellow brown.
3	Very weakly decomposed; plant structures are distinct; squeezing yields distinctly cloudy brown water, but no peat substances pass between the fingers; residue not mushy.
4	Weakly decomposed; plant structures are distinct; squeezing yields strongly cloudy brown water, but no peat substance escapes between the fingers; residue is mushy.
5	Moderately decomposed; plant structures are clear but becoming indistinct; squeezing yields much cloudy brown water and some peat material escapes between the fingers; residue very mushy.
6	Moderately strongly decomposed; plant structures are somewhat indistinct but clearer in the squeezed residue than in the undisturbed peat; about a third of the peat material escapes between the fingers; residue strongly mushy.
7	Strongly decomposed; plant structures are indistinct but recognizable; with squeezing, about half the peat material escapes between the fingers.

8 Very strongly decomposed; plant structures are very indistinct; with squeezing, about two-thirds of the peat material escapes between the fingers; residue consists almost entirely of resistant remnants such as root fibres and wood.

9 Almost completely decomposed; plant structures are almost unrecognizable; with squeezing, nearly all the peat material escapes between the fingers.

10 Completely decomposed; plant structures are unrecognizable; with squeezing, all the peat material escapes between the fingers.

25. GENERAL COMMENTS ON SOIL CHARACTERISTICS

This section of the Soil Description Form provides space to describe in free format overall soil characteristics that are not formally accommodated on the form. It also provides extra space for horizon notes where not enough space is available in Item 14. Project specific dummy variables can be created in this section which will allow for computer retrieval or sorting of information. Information that the surveyor does not want recorded in the computer data bank must be clearly labelled "*Do not code*". In addition, the soil water regime characteristics described later can be coded here.

26. SOIL TEMPERATURE

Soil temperature (°C) is determined by inserting a soil thermometer horizontally into the soil profile wall soon after the pit is dug, allowing it to attain equilibrium with the soil, then recording the reading. Measurement at one or more of the following standard depths is suggested (ground surface is 0 cm): 0, 5, 10, 20, 50, and 100 cm. It is also suggested that the temperature at 50 cm be measured first, since this value can be used to determine soil temperature class (see Item 29, Chapter Two). Record the depth right justified to the nearest centimetre (no decimals allowed), and temperature right justified to one decimal place.

27. SCHEMATIC SOIL PROFILE

The schematic soil profile diagram visually illustrates the vertical relationship of the soil horizons defined on the soil form, as well as the presence of "pockets" of particular soil features. The diagram is useful for soil correlation and for inclusion in the soil report for the project area. An example is given in Figure 3.5. The diagram is not entered into the computer data bank.

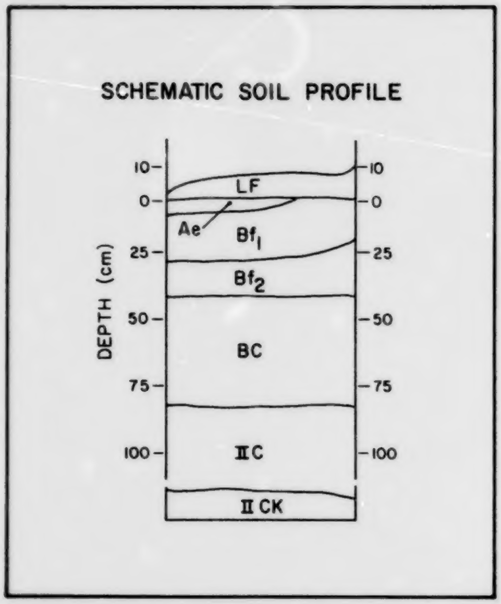

Figure 3.5 An example of a schematic soil profile diagram

SOIL WATER REGIME

The soil water regime classification (Expert Committee on Soil Survey, 1981; LRRI, 1983) utilizes the factors of soil drainage, aridity, hydraulic conductivity, least and greatest depth of saturated zone and its duration, seepage, impeding layers for both reduced and increased porosity, and modifiers for man-made conditions. The classification applies only to soils without permafrost.

The following briefly describes the classification factor classes and how to code the information in "General Comments on Soil Characteristics" (Item 25). For a complete discussion of the soil water regime classification, refer to Expert Committee on Soil Survey (1981). Soil drainage classes are not coded here as they have already been described in Chapter Two, Item 31.

Aridity (A)

Aridity classes are applicable to soils in semiarid and drier soil climates (water deficits >12.7 cm) lacking a moisture supply from a zone of saturation within 2 m of the surface in the growing season (or 3 m if the particle size is loamy or finer). Aridity index is the long term average of the supplemental water required to maintain plant available water equal to, or greater than one-half of capacity throughout the growing season for a perennial crop. The class codes are:

Class Code	*Aridity Index* (mm)	*Class Code*	*Aridity Index* (mm)
1	<100 mm	7	350–399
2	100–149	8	400–449
3	150–199	9	450–499
4	200–249	10	500–549
5	250–299	11	550–600
6	300–349	12	>600 mm

Enter "A" in space 16 and the appropriate code right justified in spaces 17-18 of the first line (transaction identifier ADDPO5) of Item 25, followed by a semicolon in space 19.

Hydraulic Conductivity (HC)

The hydraulic conductivity class is determined by the layer of least vertical saturated hydraulic conductivity within 2 m of the soil surface, including organic horizons. The codes provide an option in degrees of precision between 3 or 8 classes. Enter "HC" in spaces 20-21 and either the appropriate two character detailed code in spaces 22-23, or the one character generalized code in space 22, followed by a semicolon in space 24. The codes are:

General Code		*Detailed Code*		*Vertical Saturated Hydraulic Conductivity (cm/hr)*
L	Low	L1	extremely slow	<0.015
		L2	very slow	0.015-0.15
		L3	slow	0.15-0.5
M	Medium	M1	moderately slow	0.5–1.5
		M2	moderate	1.5–5.0
		M3	moderately rapid	5.0–15
H	High	H1	rapid	15–50
		H2	very rapid	>50

Saturated Zone (SZ)

The estimated (or measured) average annual least and greatest depths to soil that is saturated for two consecutive days or longer determines the saturated zone class. There is a choice of 3 general or 7 detailed classes. Enter "SZ" in spaces 25-26, the appropriate codes for least depth in spaces 27-28, and the codes for greatest depth in spaces 29-30. The one character, generalized codes are entered left justified in spaces 27 and 29 respectively. A semicolon is entered in space 31. The codes are:

General Code		Depth (cm)	Detailed Code		Depth (cm)
H	High	<100	H1	very high	0–50
			H2	moderately high	50–100
M	Medium	100–200	M1	medium high	100–150
			M2	generally low	>150
			M3	medium low	150–200
L	Low	>200	L1	moderately low	200–300
			L2	very low	>300

The "generally low" (M2) class is used in situations where no estimates beyond 150 cm depth are being attempted. A perched zone of saturation is classified no differently than continuous groundwater since this situation is identified elsewhere in the classification. The perched zone, however, must be at least 10 cm thick to warrant recognition.

Persistence (P) — Duration of Least Depth

Persistence subclasses are based on the duration of saturation within the depth limits of the least depth class (i.e., highest water table). The need for these subclasses commonly arises for soils with perched water tables because the condition may be either ephermeral or long lasting. It may be necessary in some areas to record whether the duration of high water table is more or less continuous or consists of the sum of many fluctuating peaks; in this case the addition of an "ephemeral" modifier is left to local discretion and definition, but with the possibility of eventually incorporating it in the system.

Enter "P" in space 32 and the detailed subclass code in spaces 33 and 34, or the general code in space 33. A semicolon is entered in space 35. The codes are:

General Code		Detailed Code	Duration of Least Depth (days)
S	short	S1	2–10
		S2	10–20
M	medium	M1	20–40
		M2	40–60
P	prolonged	P1	60–120
		P2	120–240
		P3	>240

Seepage (S)

Seepage subclasses are used to denote *major seepage* that has significant impact on biological response or soil performance. Major seepage is that occurring in soils saturated at some depth within 2 m of the surface for several weeks during the year and several days after precipitation. Enter "S" in space 36 and the appropriate seepage subclass code in space 37, followed by a semicolon in space 38.

Code	Seepage Subclass	Criteria
E	Enriching seepage	raises plant productivity
N	Neutral seepage	little significant effect on plant productivity, or effect indeterminate
D	Deleterious seepage	depresses plant productivity (e.g., saline seeps)

Impeding Layers (IL)

Depth to a significant impeding soil layer or pore space discontinuity occurring between 20 and 200 cm is recorded using the appropriate codes. *Subclass A* codes refer to depth to reduced porosity resulting in either significant reduction of hydraulic conductivity (i.e., <30% of hydraulic conductivity of the overlying layer) or significant perched saturation. *Subclass B* codes refer to depth to increased porosity sufficient to restrict water movement significantly (e.g., loam over gravel).

Enter "IL" in spaces 39-40 and subclass A codes in spaces 41-42, and subclass B codes in spaces 43-44, followed by a semicolon in space 45.

Code	*Depth (cm)*
A1 or B1	20 – 50
A2 or B2	50 – 100
A3 or B3	100 – 150
A4 or B4	150 – 200

Man-Made Modifiers (MM)

Man-made modifiers are used to identify two degrees of impact, minor and major, of long-term modification of soil water regime. Up to three codes may be entered. Enter "MM" in spaces 46-47. Major modifiers are two character codes and should be listed in spaces 48-49, 50-51, and 52-53 (if applicable). Minor modifiers, if present, are listed after the major modifiers, or if no major modifiers exist, in spaces 48, 50, and 52 using the appropriate one character code.

Major Code	*Minor Code*	*Modifier*
DD	D	ditched (open, covered)
TT	T	tube drained (tile, plastic)
MM	M	mole drained (unlined)
SS	S	subsoiled
RR	R	ridged, listed, plancheron
II	I	irrigated
XX	X	raised water level (e.g., by dams, drainage scheme discharges, etc.)

SOIL SAMPLING

The value of laboratory analysis depends on the appropriate selection of sampling sites; the care with which samples are collected; and the degree to which laboratory data can be related to field description.

Abbreviated soil descriptions should be detailed enough to confirm differentiating criteria. Detailed soil descriptions and samples should be taken to the bottom of the control section. For mineral soils, the control section usually extends to 25 cm below the upper boundary of the C horizon, but is at least 1 m and no more than 2 m in depth. For organic soils, the control section extends to a depth of 160 cm from the surface. In both mineral and organic soils, bedrock limits control the depth of the control section.

Soil samples must be related to the soil profile description. For detailed descriptions, each soil horizon identified on the description form should be sampled. Samples should be representative of the entire cross-section of the horizon. If horizons vary greatly in thickness or are discontinuous, a composite sample from different areas of the horizon should be taken to ensure a representative sample. Interfingered or discontinuous horizons should not be mixed. If contrasting soil horizons are too thin or too intimately mixed to allow separate sampling, the proportion of each should be estimated and recorded.

If horizons (or subhorizons) are greater than 25 cm thick in the upper portion of the profile or greater than 50 cm thick in the lower portion, arbitrary subhorizons should be defined and sampled. Artificial subdivision of horizons less than 8 cm thick is usually not needed.

Coarse fragment percentages by volume per size class should be estimated (or measured) and the less than 2 mm size fraction sampled for analysis. The C horizon samples should be taken as soon as the pit is dug to prevent contamination. The soil should then be fully described and the pit face cleaned from the top down and sampled from the bottom up to prevent contamination. Samples should be double bagged and each sample labelled. The label should contain at least the following information:

1. Project identification
2. Surveyor Name
3. Site Description Series and Form Number
4. Soil Pit Number (if more than one per plot)
5. Horizon designation and depth

If samples collected by the Ministry of Environment are to be analyzed at the ministry contracted laboratory, laboratory requisition forms (see next page) must be completed and accompany the samples. Standard soil sample labels should also be used (these are available from the MAPS — B.C.). Horizon *level* on the requisition forms and labels must be completed for all samples sent for analysis and correspond to those on the Soil Description Forms. Refer to Quesnel and Sondheim (1983) for more information.

If laboratory analyses are to be linked with other field collected data using BCSIS, the laboratory results have to be coded on "Manual Soil Laboratory" forms for key-punching and computer entry. These can also be ordered from MAPS — B.C.

SOIL LABORATORY REQUISITION FORM

Form Number: ☐☐-☐☐☐☐☐

Project ID:

Agency

Surveyor:

Address:

Phone:

Level	Disc.	Hor.	Suffixes	Sub.	Depths	Grab	STANCHEM	FEAL01	FEAL02	FEAL03	EC	FIBRE	TISSUE	SIEVE-1	ATBERG	SIEVE-2	GEOSIPET	PIPET	F-CLAY	AWSC	TOT-P	TOT-S	CALCARB	H/F	BD	MIN-N	NH4-N	NITRATE	Miscellaneous A	B	C	D	E	F	G	H	I
☐				☐		☐																															

Other:

Comments:

☐				☐		☐

Other:

Comments:

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Other:

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Other:

Comments:

[illegible] ENV 1022

Province of British Columbia Ministry of Environment Ministry of Forests

Level	Disc.	Hor.	Suffixes	Sub.	Depths	Grab	STANCHEM	FEALO1	FEALO2	FEALO3	EC	FIBRE	TISSUE	SIEVE-1	ATBERG	SIEVE-2	GEOSIPET	PIPET	F-CLAY	ARSC	TOT-P	TOT-S	CALCARB	H/T	BD	MIN-N	NH4-N	NITRATE	Miscellaneous								
																													A	B	C	D	E	F	G	H	I
						Other:																															
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CHAPTER 4

VEGETATION DESCRIPTION

VEGETATION DESCRIPTION FORM

PROJECT ID. ______ PLOT NO. ______ SURVEYOR ______ PAGE ___ OF ___

1 2 3 4 5 6 7 8	9 10 11 12	13 14 15 16	17 18 19 20	21 22 23 24	25 26 27 28	29 30 31 32	33 34 35 36	37 38 39 40	41 42 43 44	45 46 47 48	49 50 51 52	53 54 55 56	57 58 59 60	61 62 63 64	65 66 67 68	69 70 71 72	73 74 75 76
SERIES &8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
FØRM NØ.																	
STRATUM	A0 Veterans	A1 Dominant Trees	A2 Main Canopy	A3 Trees	A Total Trees	B1 Tall Shrubs	B2 Low Shrubs	B Total Shrubs	C Herbs	D Mosses, Lich.	N Liv. Seedling All Strata	P	T Phenology	U Dead Tree	F Utilization	S Forage g/m²	X1 Typical Substrate Project Specific
ENTRIES	PPDV	PPDV	PPDV	PPDV	PPDV	PPDV	PPDV	PPDV	PPDV	PPDV	PPDV	EEGG	NNLC	RFU	WWWM	SA	

FIELD NAME
OR COLLECTION #

TØT%CØV.	
STRAT HT	
DEADTREE	
CØMMENT1	
CØMMENT2	

Province of British Columbia
Ministry of Environment and Parks
Ministry of Forests and Lands
Ministry of Agriculture and Fisheries
[illegible]

ENV 1915

VEGETATION DESCRIPTION FORM (cont.)

	1 2 3 4 5 6 7 8	9 10 11 12	13 14 15 16	17 18 19 20	21 22 23 24	25 26 27 28	29 30 31 32	33 34 35 36	37 38 39 40	41 42 43 44	45 46 47 48	49 50 51 52	53 54 55 56	57 58 59 60	61 62 63 64	65 66 67 68	69 70 71 72	73 74 75 76
	SERIES &	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐
	FØRM NØ.																	
	STRATUM	A0	A1	A2	A3	A	B1	B2	B	C	D	Z	P	T	U	F	S	X1
FIELD NAME OR COLLECTION #	ENTRIES	P P D V	P P D V	P P D V	P P D V	P P D V	P P D V	P P D V	P P D V	P P D V	P P D V	P P D V	E E G G	N N L C	R F U	W W W M	S A	

Chapter Four

VEGETATION DESCRIPTION

INTRODUCTION

The Vegetation Description Form is for recording the characteristics of the vegetation in the sample plot. To ensure that the form is used consistently, the following definitions and basic data requirements are discussed. Project I.D. and Plot No. are taken from the Site Description Form and entered in the appropriate place. Surveyor is the name of the individual filling out the vegetation form.

SERIES AND FORM NUMBER

In most cases, one Vegetation Description Form is completed for a single sample plot. The Series and Form Number, taken from the Site Description Form, is entered in the first and second rows of columns 9 through 12 for both sides of the Vegetation Description Form (if both sides are used). For example, where the Series is 82 and the Form Number is 01234, 820 is entered in the first row (leaving the shaded box in column 12 blank) and 1234 is entered in the second now. Each Vegetation Description Form has enough space to record 45 species; if more occur, use another form and repeat the appropriate Series and Form Number in columns 9-12.

The form may also be used to record data from several plots on a single sheet. For example, in a grassland survey where only two strata are of interest (e.g., Low Shrubs (B2) and Herbs (C)), the form might look like the following:

821 2345		821 2346		821 2347	
B2	C	B2	C	B2	etc.
A0	A1	A2	A3	4	
PPDV	PPDV	PPDV	PPDV	PPDV	

The Series and Form Number need only be entered when they are different from the "Stratum" entry on the immediate left. In this way, from one to 34 plots can be coded on a single description form. However, a separate Site Description Form must be completed for each plot.

In cases where a number of vegetation plots are all on the same site, the "subplots" can be coded on the same form. Identify subplots by entering alphabetic characters in the shaded spaces where Series and Form Numbers are recorded. For example, if the Herb (C) layer is being sampled with three subplots in plot 82-12345, the top of the form would look like this:

	821 2345	821A 2345	821B 2345	821C 2345
. . . .		C	C	etc.
	B	C	D	Z
	PPDV	PPDV	PPDV	PPDV

In this example, the alphabetic characters are entered in the shaded boxes in columns 44, 48 and 52. There are many possible variations of this procedure -the consideration is to ensure that the subplots all refer to the same Site Description Form.

SPECIES LIST

The species list is for recording all the species growing in the sample plot. At a minimum, all species growing on the dominant substrate should be recorded. Depending on the nature of the study or the features of a particular plot, species growing on other substrates (e.g., bedrock, decaying wood) may also be recorded.

All species names should be entered in columns 1 to 8 using the 4-3-1 (genus — species — subspecies or variety) code from the B.C. Ministry of Forests' *Vegetation Coding List* (Titus, 1980). This list ensures the use of a unique code for each plant taxa.

Data recorded in a systematic manner are generally much easier to read and compile, and lead to better organization in the field. One common method is to list plants in groups by strata, starting with the uppermost stratum and progressing to the lower strata. Within each stratum it is often helpful to start with the dominant species.

Ministry of Forests surveyors should end their species list with the number "1" in column 1 after the last species entry. This is used as an end of plot indicator in the analysis of the data.

A "Field Name or Collection #" can be entered on the left of the form until plant collections are verified. This name or number is not entered into the computer data bank, and is only for the convenience of the surveyor. For a complete plant species list, all unknown species must be collected for subsequent verification. Each unknown plant should be numbered sequentially within a plot and either the form or plot number, and sequential number recorded on the collection bags and pressing sheets. A system such as this is extremely important in a project where there are several persons collecting data, or where there is a significant time lag between field collection and office verification, coding, and mounting. This system provides an easy check, both in the field and the office, that all unknown plants were collected. As well, it ensures that there is no confusion between plant collections and field names on the description form and that all plants can be easily referenced to a set of field notes.

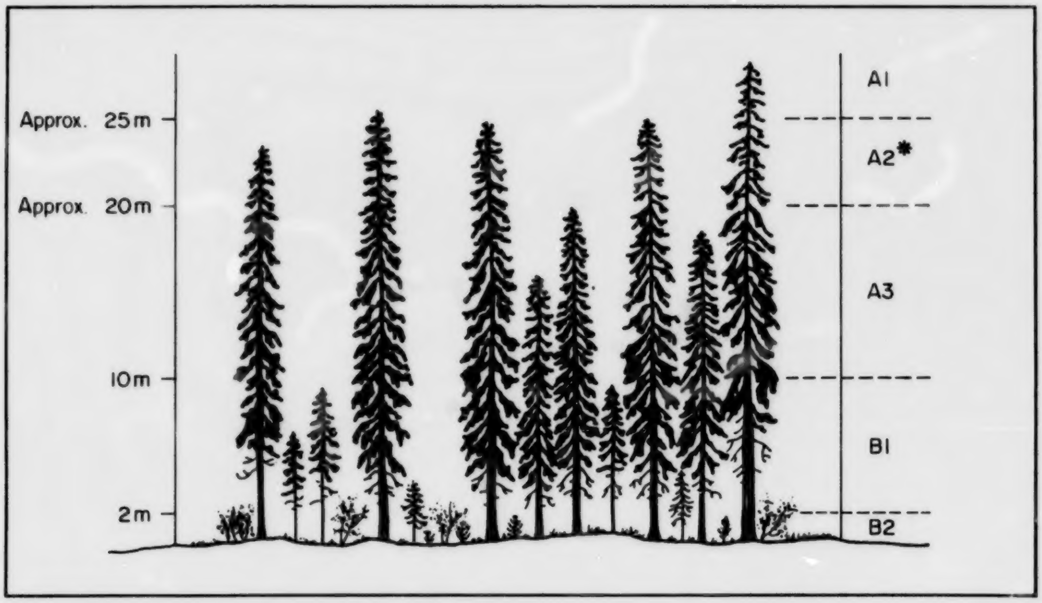
Ensure that sufficient sample is collected for identification of each unknown plant. Duplicate collections should be made if samples are being distributed to others for verification. For each project, at least one voucher specimen of each species should be submitted to the Royal British Columbia Museum, or the University of British Columbia herbarium. Refer to "Collection Techniques and Herbarium Procedures for Vascular Plants and Cryptogams" (Douglas, in prep.) for further information.

STRATUM AND ENTRIES

In most surveys, percent cover values (PP) for species growing on the dominant substrate are recorded in the main portion of the form (columns 9-52) by strata. However, the objectives of a study or the features of a particular site may warrant collecting data for species growing on other substrates. The form is flexible and data collected for a variety of objectives can be incorporated.

The use of stratum aids in describing the appearance of the the community at the time of sampling, as it relates primarily to the vertical spacing and height of the plants making up the "stand". The vertical structure, or stratification, may provide useful information about successional status and inter-species relationships.

The main Stratum categories follow. Figure 4.1 depicts the stratification of an idealized forest stand in the interior of British Columbia.



* some exceptions for very low growing stands.

Figure 4.1 Stratification of forest stands, shrubs and trees.

Veterans (A0)

These are trees that are significantly older than the trees of the main canopy. The species may have survived one or more fire as evidenced by fire scars. The veterans are usually isolated in distribution and often extend well above the main tree canopy. The trees of stands that have survived ground fires are not considered veterans. (When in doubt, determine the ages of the main tree canopy species and compare them with the age of the presumed veteran).

Dominant Trees (A1)

This stratum records information about the dominant (tallest) trees species of the main canopy. These are the trees that make up the upper part of the height distribution population of the main canopy. Included may be trees of the same age group as the main canopy but are significantly taller. The dominant trees are usually a minor portion of the stand composition.

Main Tree Canopy (A2)

This is the main upper layer of tree cover, composed of trees whose crowns form the upper layer of foliage, above 10 m in height. The main tree canopy forms the major portion of the stand composition. Trees in this layer are also called "codominants".

Trees (A3)

There are trees over 10 m high but do not reach the main tree canopy. In some cases they may form a secondary canopy, but often are just a mixture of trees younger than those of the main canopy, or are 'suppressed' trees of about the same age. This category includes what are termed "intermediate" and "overtopped" trees (of a single tree layer) by the Inventory Branch, B.C. Ministry of Forests.

Total Trees (A)

This column records the collective percent coverage of the ground surface by the vertically projected crowns for each plant species in the combined A0, A1, A2, and A3 layers. The value is an estimate of the actual total tree cover by one species, not an addition of the individual values for each stratum. It cannot be less than the highest cover of any one of the four strata, and it cannot exceed the sum of all four entries, or theoretically 100% (99 is the maximum percent value that can be coded). Usually, because of crown overlaps, the actual cover will lie between the sum of the four values and the highest single value.

Tall Shrubs (B1)

This stratum is comprised of all woody plants between 2 and 10 m tall, including shrubs and advanced tree regeneration. In some poorly growing stands, the canopy of mature trees may be less than 10 m and should be recorded here.

Low Shrubs (B2)

This stratum consists of all woody plants less than 2 m high (except those listed in Table 4.1), including shrubs and established tree regeneration (more than 2 years old). Also included are dwarfed specimens of species normally considered in the shrub category (e.g., young forms of *Vaccinium membranaceum*, or dwarf alpine forms of normally taller shrubs). Most low (<15 cm) woody or trailing plants should be recorded in the herb (C) layer (see Table 4.1).

Total Shrubs (B)

This column records the collective percent of the plot area covered by the vertically projected crowns of each plant species in the combined B1 and B2 layers and is an estimate of the total shrub cover. The assigned value should at least equal the higher of the coverages of the individual stratum (B1 or B2), but should not exceed the total of the two, or theoretically 100% (99 is the maximum percent value that can be coded).

Herbs (C)

Herbaceous species, regardless of their height, and some low woody plants should be recorded in this stratum. Table 4.1 lists species of doubtful lifeform and low shrubs (generally <15 cm tall) which are assigned to the herb layer.

Table 4.1 List of low woody species and species of doubtful lifeform assigned to the herb (C) layer

*Andromeda polifolia**

Anemone multifida
Apocynum androsaemifolium
Apocynum cannabinum
Apocynum pumilum
Apocynum sibiricum

*Arctostaphylos alpina**
*Arctostaphylos rubra**
*Arctostaphylos uva-ursi**

Aruncus dioicus

Asclepias ovalifolia
Asclepias speciosus

*Cassiope lycopodioides**
*Cassiope mertensiana**
*Cassiope stelleriana**
*Cassiope tetragona**

Chamaerhodos erecta

*Chimaphila menziesii**
*Chimaphila umbellata**

Comandra umbellata

Cornus canadensis
Cornus suecica
Cornus unalaschkensis

Draba spp.

Dryas drummondii
Dryas integrifolia
Dryas octopetala

*Empetrum nigrum**

Eriogonum androsaceum
Eriogonum flavum
Eriogonum heracleoides
Eriogonum niveum
Eriogonum ovalifolium
Eriogonum pauciflorum
Eriogonum umbellatum

Frageria chiloensis
Fragaria vesca
Fragaria virginiana

Galium boreale

*Gaultheria humifusa**
*Gaulitheria hispidula**
*Gaultheria ovatifolia**

Geocaulon lividum

Kalmia microphylla ssp. *microphylla**

*Linnaea borealis**

Lithospermum incisum
Lithospermum ruderale

*Loiseleuria procumbens**

*Luetkea pectinata**

Orthilia secunda

*Penstemon davidsonii**
*Penstemon ellipticus**

Phlox caespitosa

*Phyllodoce empetriformis**
*Phyllodoce glanduliflora**

Polygonum cuspidatum
*Polygonum paronychia**
Polygonum polystachyum
Polygonum sachalinense

Pyrola spp.

*Rhododendron lapponicum**

Rubus arcticus
Rubus chamaemorus
Rubus lasiococcus
*Rubus nivalis**
Rubus pedatus
*Rubus ursinus**

*Salix arctica**
*Salix cascadensis**
*Salix polaris**
*Salix reticulata**
*Salix stolonifera**

Saxifraga bronchialis
Saxifraga cespitosa
Saxifraga flagellaris
Saxifraga oppositifolia
Saxifraga tricuspidata

Sibbaldia procumbens

*Vaccinium caespitosum**
*Vaccinium oxycoccus**
*Vaccinium scoparium**
*Vaccinium vitis-idaea**
Vaccinium myrtillus

* These woody or herbaceous species are often considered as low shrubs.

Mosses, Lichens, Liverworts and Seedlings (D)

This stratum records information pertaining to the mosses (bryophytes), lichens, liverworts, and tree seedlings (<2 years old) growing on the dominant substrate. Fungi growing on the dominant substrate can also be recorded.

All Strata (Z)

Record in this column the combined coverage of the plot by the vertically projected crowns of each species occupying one or more stratum. The value will differ from the "Total Trees" or "Total Shrubs" estimates for species occurring in both tree and shrub layers, but will be the same for species restricted to only the tree or shrub layers. The "total cover" of the plot by all vegetation, should be recorded in this stratum in the "TOT%COV." row near the bottom of the description form.

The suggested entries for all of the previous strata are percent cover (PP), distribution (D), and vigour (V). These are defined as follows:

Percent Cover (PP)

Percent cover is the percent of the ground area covered by a vertical projection of the crown of the plant onto the ground surface. When estimating percent cover, care must be taken not to bias estimates because of crown density. Except for distinct holes in the crown, the area within the perimeter of the crown is assumed to be fully covered. It is recommended that percent cover be recorded for each species in each plot.

To aid in assessing percent cover, a set of comparison charts are provided in Figure 4.2. Another method is to determine the ground surface area of the plot representing certain percentages. For example, in a 20 × 20 m (400 m^2) plot, 0.1% of the area is 0.4 m^2 or 63 × 63 cm; 1% of the area is 4 m^2 or 2 × 2 m; 10% is 40 m^2 or 5 × 8 m; and 25% is 100 m^2 or 10 × 10 m. Figure 4.3 illustrates some relative amounts of percent coverage.

Permissible entries vary from *.1* to *01* to *99*. Only the digits 0 through 9 and the decimal point may be entered; the symbols <, >, +, T, etc., are not allowed. A percent cover of 100% is assumed to be adequately represented by a PP entry of 99.

Distribution (D)

The distribution code records information on the spatial distribution pattern of individuals of each species. This may be useful data for those species which, because of their size, only cover a minor part of the plot area (e.g., less than 1%) but can occur singly or in several patches. Table 4.2 presents the Distribution Codes to be used.

The assessment of distribution must be conducted at a scale appropriate for the size of the species. A relatively small area (e.g., 20 × 20 m) can be used to adequately assess the distribution of mosses (D), herbs (C), and low shrubs (B2). However, the spatial patterns of tall shrubs (B1) and trees (Veteran, A1, A2 and A3) are not adequately represented in such a small area. Wherever possible the distribution of trees and tall shrubs should be assessed over an area of about 0.5 – 1 ha around the plot, if the surrounding stand is homogeneous.

The guidelines in Table 4.2 are intended to be general only. The numbers and distances have been subjectively derived and have not been rigorously tested. Guidelines for a 20 × 20 m area are given for low shrubs, herbs, and mosses, and, for a 100 × 100 m (1 ha) area for tall shrubs and trees. The guidelines aid in the estimation of the distribution patterns described and illustrated in the diagrams.

For the purposes of coding, an individual plant is defined as either a single stem, a number of stems arising from the same caudex or main stem, or a "bunch" as in bunchgrasses and other caespitose plants (i.e., the individual is the bunch, having numerous stems). For plants that are rootgrafted, or connected by runners or rhizomes, or distinct members of clones, each stem (above ground portion) is considered to be a distinct individual.

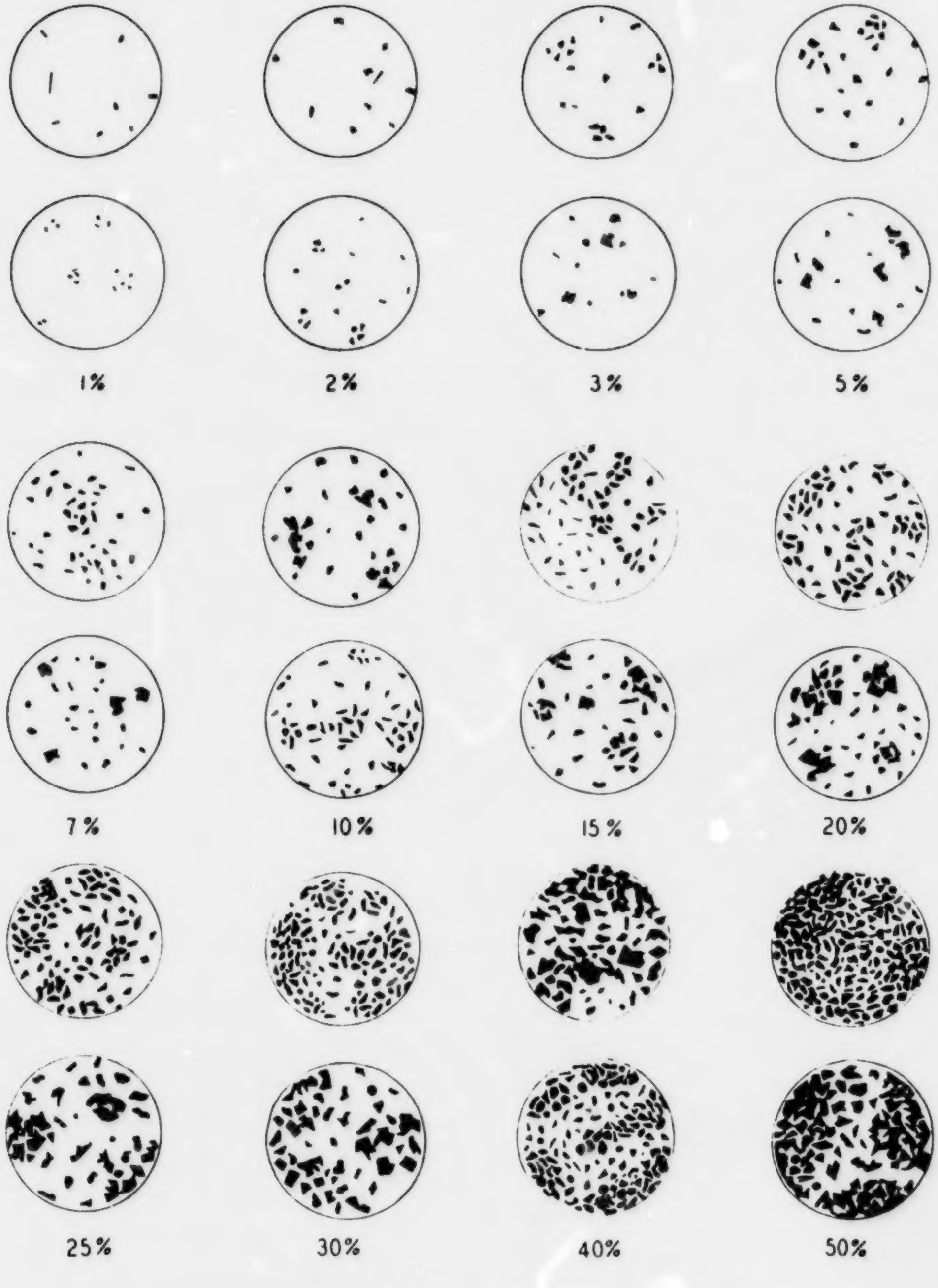


Figure 4.2 Comparison charts for visual estimation of foliage cover.

Developed by Richard D. Terry and George V. Chilingar. Published by the Society of Economic Paleontology and Minerology in Journal of Sedimentary Petrology 25(3): 229–234, September 1955.

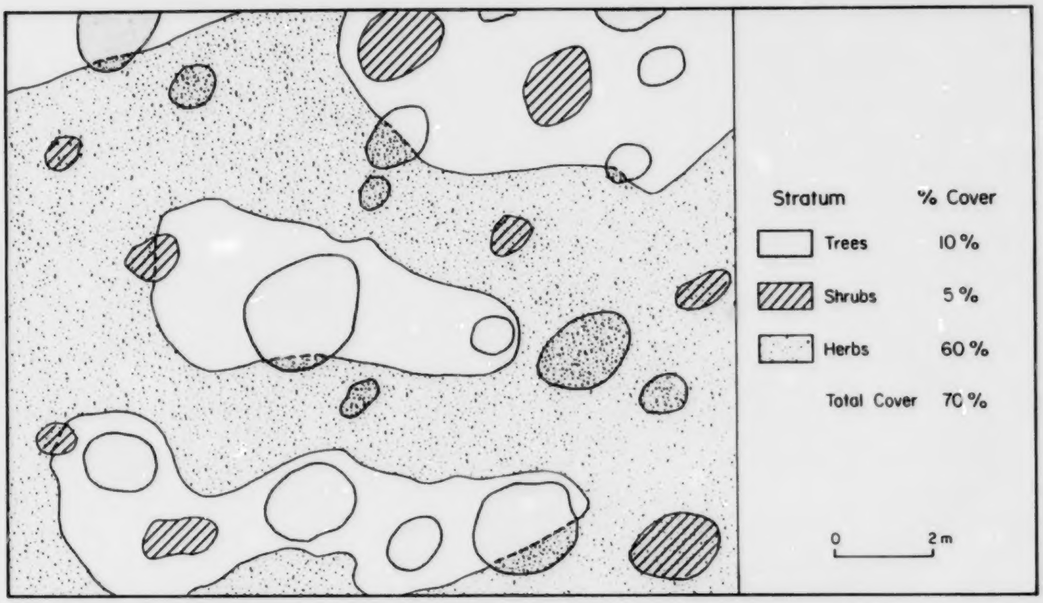
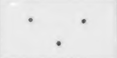
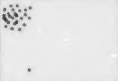
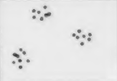
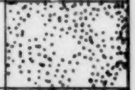
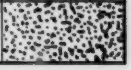


Figure 4.3 An example of percent coverages in a plot as viewed from above.

Table 4.2 Distribution Codes

Code	Description	Guidelines for Field Assessment*		
		No. of plants in 20 × 20 m area (low shrubs, herbs and mosses)	**No. of plants/ha 100 × 100 m area (tall shrubs and trees)**	**Diagram**
1	rare individual, a single occurrence	1	<5	
2	a few sporadically occurring individuals	2–5	5–50	
3	a single patch or clump of a species	1 patch (occupying an area smaller than one quadrant of the plot)	variable (3 patches)	
4	several sporadically occurring individuals	≥6	>50	
5	a few patches or clumps of a species	2–5 patches (each occupying an area smaller than one quadrant of the plot)	variable (3–10 patches)	
6	several well-spaced patches or clumps	≥6 patches (each occupying less than one quadrant of the plot)	variable (10–many disjunct patches)	
7	continuous uniform occurrence of well-spaced individuals	many	many	
8	continuous occurrence of a species with a few gaps in the distribution	many	many (continuous matrix formed by species crowns with some openings)	
9	continuous dense occurrence of a species	many	many	

* The distribution code is determined over a sufficiently large area to account for normal variation in distribution pattern.

Vigour (V)

Vigour should be assessed and recorded according to the five-class scale in Table 4.3. It allows the comparison of growth of a species on different sites, and can be assessed in relation to the growth of a species under particular climatic conditions (e.g., biogeoclimatic subzone), rather than to the whole range of the species.

The assessment of vigour, therefore, requires some familiarity with the range of growth of a species within particular climatic conditions. This can usually be achieved in the initial reconnaissance of an area, or at the start of field sampling.

Some features of plants often considered in vigour assessment are: size, apparent rate of growth, size of leaves, abundance of flowers or fruit, and whether or not the plant is chlorotic. The "average" plant growing reasonably well is considered to have "good" vigour (code = 3).

Table 4.3 Vigour ratings

Code	Description
0	Species Dead
1	Vigour Poor
2	Vigour Fair
3	Vigour Good
4	Vigour Excellent

Other Entries

Other entries are possible for species in any of the previously described strata. Strike out PP on the form, for example, and replace it by the appropriate code:

LL: percent cover on a line intersect basis. Equivalent to PP but based on a line instead of an area. Entries would then be L L D V or L L __ __.

SS: species significance or Domin-Krajina scale (0-9). Although it is recommended to collect data in percent cover and then convert to a scale if necessary, some surveyors may prefer to collect data using the Domin-Krajina or another scale — for example, Braun-Blanquet (BB). Entries would then be S S __ V or B B __ V, etc.

A surveyor may also wish to estimate the percent of the total green weight (g/m^2) of a plot occupied by a given species. It is recommended that this value of "percent estimated composition" be given the code, CC. The CC could be used in place of D and V, or as a substitute for PP. The entries would then be either P P C C or C C D V. Note that the total amount of forage produced by a species (in all strata) can be entered in columns 65 to 68.

Other strata and entries across the top of the form are as follows:

PHENOLOGY (P)

Phenology refers to the stages a plant passes through in its annual life cycle. Vegetative stages describe germination to death in annual herbs and forbs, and bud to leaf, as well as shoot development in perennials. Development of flowers and fruits is covered by a set of generative codes.

The codes in Table 4.4 are to be recorded in columns 53-56; the vegetative (EE) and generative (GG) codes are both entered right justified. The recorded code consists of a number from 0 to 10 indicating the vegetative phenological state, and a number from 0 to 13 indicating the generative phenology. For example, the code 0301 for *Aralia nudicaulis* indicates the herb has 2 or 3 unfolded leaves and recognizable blossom buds.

Phenology can also be entered as the percent of the total annual growth, on a mass basis, that has been reached at the time of the survey. To enter this information, strike out either EE or GG and enter AA (e.g., __ __ A A).

Table 4.4 Phenology codes (after Dierschke, 1972)

VEGETATIVE (EE)		GENERATIVE (GG)
Deciduous Tree or Shrub	*Conifer*	
0 Closed bud	0 Closed bud	0 Without blossom buds
1 Buds with green tips	1 Swollen bud	1 Blossom buds recognizable
2 Green leaf out but not unfolded	2 Split bud	2 Blossom buds strongly swollen
3 Leaf unfolding up to 25%	3 Shoot capped	3 Shortly before flowering
4 Leaf unfolding up to 50%	4 Shoot elongate	4 Beginning flowering
5 Leaf unfolding up to 75%	5 Shoot full length, lighter green	5 In bloom up to 25%
6 Full leaf unfolding	6 Shoot mature, equally green	6 In bloom up to 50%
7 First leaves turned yellow		7 Full bloom
8 Leaf yellowing up to 50%		8 Fading
9 Leaf yellowing over 50%		9 Completely faded
10 Bare		10 Bearing green fruit
		11 Bearing ripe fruit
		12 Bearing overripe fruit
		13 Fruit or seed dispersal
Herbs		
0 Without shoots above ground		0 Without blossom buds
1 Shoots without unfolded leaves		1 Blossom buds recognizable
2 First leaf unfolds		2 Blossom buds strongly swollen
3 2 or 3 leaves unfolded		3 Shortly before flowering
4 Several leaves unfolded		4 Beginning bloom
5 Almost all leaves unfolded		5 Up to 25% in blossom
6 Plant fully developed		6 Up to 50% in blossom
7 Stem and/or first leaves fading		7 Full bloom
8 Yellowing up to 50%		8 Fading
9 Yellowing over 50%		9 Completely faded
10 Dead		10 Bearing green fruit
		11 Bearing ripe fruit
		12 Bearing overripe fruit
		13 Fruit or seed dispersal
Grasses		
0 Without shoots above ground		0 Without recognizable inflorescence
1 Shoots without unfolded leaves		1 Inflorescence recognizable, closed
2 First leaf unfolded		2 Inflorescence partly visible
3 2 or 3 leaves unfolded		3 Inflorescence fully visible, not unfolded
4 Beginning development of blades of grass		4 Inflorescence unfolded
5 Blades partly formed		5 First blooms pollenizing
6 Plant fully developed		6 Up to 50% pollenized
7 Blades and/or first leaves turning yellow		7 Full bloom
8 Yellowing up to 50%		8 Fading
9 Yellowing over 50%		9 Fully faded
10 Dead		10 Bearing fruit
		11 Fruit or seed dispersal
Ferns		
0 Without shoots above ground		0 Sori absent
1 Rolled fronds above ground		1 Sori green, forming
2 First frond unfolds		2 Sori mature, darker, drier
3 2 or 3 fronds unfolded		3 Sori depressing, strobili forming in lycopodium
4 Several fronds unfolded		
5 Almost all fronds unfolded		
6 Plant fully developed		
7 First fronds fading		
8 Yellowing up to 50%		
9 Yellowing over 50%		
10 Dead		

DEAD TREES (T) by species

The number of dead stems per plot of each tree species can be coded as follows:

NN: number of dead stems/plot from 01 to 99

L: a stratum or layer code. A0, A1, A2, A3, B1, B2, C, and D are coded 0, 1, 2, 3, 4, 5, 6, and 7, respectively

C: snag class; dead, loose bark, clean, broken, decomposed, down material, and stump are coded 1 to 7, respectively

The project objectives determines what level of detail is collected in this category: e.g., number of snags in each layer and snag class for each species, or something more general. Note that the number of dead stems can also be coded by strata in the DEADTREE row near the bottom of the front page of the form (see Section on DEADTREE).

UTILIZATION (U)

The utilization and status of a plant in a range management context can be indicated as follows:

Range Condition Indicator (R)

Record whether a range species is *increasing, decreasing, invading*, or *unaffected* by grazing by using the codes 1, 2, 3 and 4, respectively. Plants that respond quickly to over-utilization by decreasing in numbers are called "decreasers". They are usually perennials that produce much high quality forage. Species that respond to over-utilization, at least initially, by increasing in relation to other plants in the community are called "increasers". They are generally low stature, less productive, subdominant species in the climax plant community. When grazed, those of low forage value tend to increase more rapidly than those of high value. Those species which are not normally a part of the climax plant community, but invade and grow along with the increasers on over-utilized sites, are called "invaders", regardless of their forage value.

Prior to sampling an area, consult the local range agrologist for examples of possible increaser, decreaser, and invader species for the particular area. The following are examples of common decreasers, increasers, and invaders on a ponderosa pine — bunchgrass site:

Decreasers	Increasers	Invaders
Agropyron spicatum	*Balsamorhiza sagittata*	*Phlox diffusa*
Festuca idahoensis	*Artemisia tridentata*	*Taraxacum officinale*
Festuca scabrella	*Antennaria microphylla*	*Plantago* spp.
	Koeleria macrantha	*Bromus tectorum*
	Chrysothamnus nauseosus	
	Poa sandbergii	
	Achillea millefolium	

Range condition ratings are most useful when applied to rangelands; that is, land on which the native vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing by wildlife or livestock. Rangelands may include alpine tundra, bunchgrass or ponderosa pine — bunchgrass communities, much of the Interior Douglas-fir forests, coastal marshes, and wet meadows.

In densely wooded situations, there is generally very little forage produced, so the process of comparing the existing stand to the predicted climax stand is not meaningful; therefore, do not rate "range condition indicators" for wildlife or domestic livestock uses in these areas. A grazable understory is produced only periodically, usually following clearcutting, extensive selective cutting or thinning, or fire. Assessing range condition indicators on these sites is difficult unless considerable experience in sampling stands at all ages is attained. Instead, describe the present stage of successional status (Item 39 on the Site Description Form) and the productivity and utilization of the key herbs and shrubs.

Form Utilization Class (F)

The form classes and codes, taken from U.S. Forest Service (1969) "Wildlife Surveys Handbook", are:

Code	*Form Class*
1	all available, little or no hedging
2	all available, moderately hedged
3	all available, severely hedged
4	partly available, little or no hedging
5	partly available, moderately hedged
6	partly available, severely hedged
7	unavailable
8	dead

The classes apply only to woody plants and should not be assessed for herbs; these should be given a "utilization rating" instead.

Availability is based on the portion of the plant used in previous winters. Form class estimates are determined for the available portions of plants, based upon the length and appearance of the previous year's growth (2-year-old wood). Refer to the form classes in Figure 4.4. As well, because more than one degree of hedging within the available portion of a plant is quite common, the form class should be the average condition of branch ends. The appearance of form classes may differ between species. For example, form class 2 or 4 for willow may be unlike form class 2 or 4 for saskatoon.

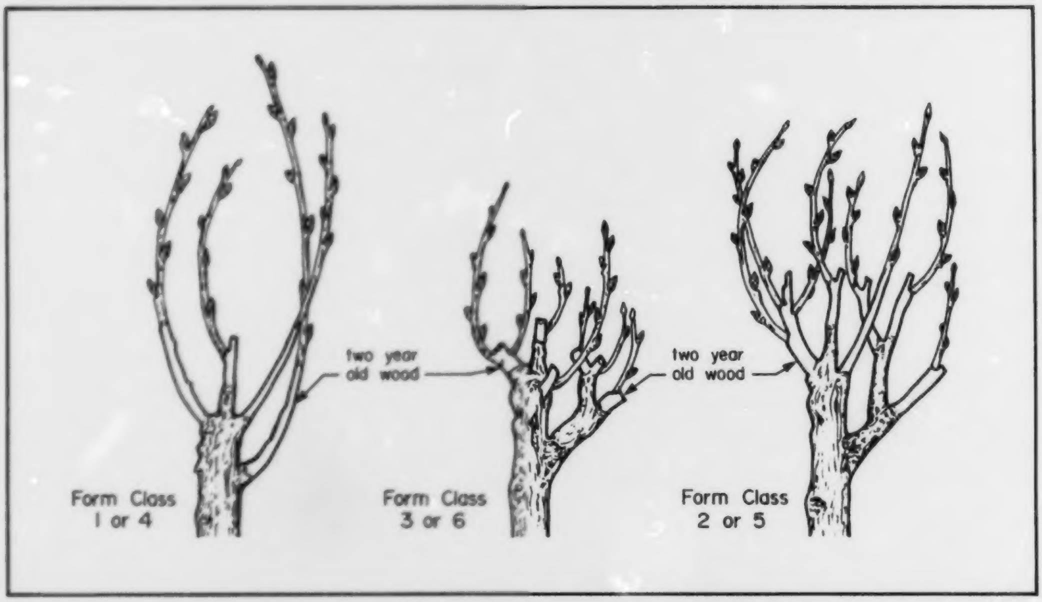


Figure 4.4 Utilization form classes (degrees of hedging)

Form classes reflect vigour and forage production of browse plants. Leaders on form class 3 and 6 plants are usually short and yield less forage than those on form class 2 and 5, or 1 and 4 plants.

In most shrub species, new leaders normally grow from terminal buds. Browsing of terminal buds causes lateral bud growth, thus altering the appearance of the shrub (see Figure 4.4). If the previous year's growth is strongly altered or is relatively short (clubbed), classify the shrub in form class 3 or 6 (severely hedged); if it is only moderately altered, classify it in form class 2 or 5 (moderately hedged); if only slightly altered or unaltered, classify it in form class 1 or 4 (little to no hedging).

To determine form class, simply ask, "Has the normal growth habit of 2-year-old wood been substantially changed?" If the answer is "yes", the form class is either 2 or 5, or 3 or 6. If the answer is "no", it is form class 1 or 4. If the form class is not 1 or 4, ask, "Is the growth clubbed or relatively short?" If the answer is "yes", it is form class 3 or 6. If the answer is "no", it is form class 2 or 5.

Utilization Rating (U)

Utilization (present use) of browse and forage species are recorded using the following codes:

Code	*% Utilization*	*Description*
0	0	Nil
1	1-15	Slight
2	16-35	Light
3	36-65	Moderate
4	66-80	Heavy
5	>80	Extreme

Determine the utilization rating by examining the previous year's growth of the forage species and estimating the amount (% of original) of the plant that has been consumed. In the case of tall trees and shrubs such as maple and willow, consider only low growth within the animal's reach. In the case of "heavy" or "extreme" ratings, some trampling damage may be evident in the herbs.

FORAGE (F)

The amount of available forage, at the time of survey, is either measured (WWW) or estimated (EEE) in g/m^2 and entered in columns 65-67. In the latter instance, cross out WWW and enter EEE. The method (M) of determining the weight is coded as follows in column 68:

Code	*Method (M)*
1	estimated green
2	estimated air-dried
3	estimated oven-dried
4	measured green
5	measured air-dried
6	measured oven-dried

The value can be entered for each species, or alternatively, for groups of species such as palatable forbs, grasses, browse species, undesirable species, etc. The objectives of a particular survey will determine the method, sampling procedure, number of subplots, etc. If available forage is determined for groups of species, this should be mentioned under "comments".

ATYPICAL SUBSTRATE (S)

Species growing on other than the dominant substrate can be listed and their abundance indicated. For a complete listing of the different kinds of substrates refer to Chapter Two on Site Description (Item 43, "Surface Substrate"). The code for the following categories should be inserted in column 71 below "S" for each species. Species found on two or more atypical substrates will have to be recorded more than once in the species column, unless the "Project Specific" columns are used for this purpose.

Code	*Atypical Substrate*
1	Epilithic — plants growing on cobbles, stones or bedrock outcrops (epi — on, lithic — rock) where this is not dominant substrate.
2	Epiphytic — plants growing on other living plants (epi — on, phytic — plant).
3	Epixylic — plants growing on dead wood where this is not the dominant substrate (epi — on, xylic — wood).
4	Episolic — plants growing on bare soil where this is not the dominant substrate (epi — on, solic — soil).
5	Mosses on Humus — plants (bryophytes) growing on atypical areas of humus cover, where the plot is not dominated by humus cover but by cover of another substrate.

Estimates of percent cover, relative to the area of the atypical substrate may be made, but these are often time-consuming and inaccurate, especially with epiphytic plants. To generally assess the abundance of plants on these substrates, use the following broad cover classes:

Code	*Abundance*	*Coverage*
1	rare to low	<25% cover
2	frequent	26-75% cover
3	abundant	>76% cover

Enter the appropriate code in column 72 below "A" for abundance class. If percent cover is provided, enter "PP" in columns 69-70.

PROJECT SPECIFIC (X1)

Any project specific information may be coded here in alpha or numeric code. One or more letters should be coded in Entries at the top of the columns used to identify the parameter being considered. Also, as mentioned previously, any of the Stratum or Entries codes can be crossed off and other project specific strata or entries added.

For instance, it may be important to note berry abundance for a particular project. This can be accomplished in a number of ways. One way is to enter the letter "S" for "percent stems bearing fruit" in column 73 under "Entries" and "A" for "average abundance of berries on stems" in column 74. Then for each plant species assessed, the following codes from Hamilton and Archibald (1984) can be entered:

% Stems Bearing Fruit (S)	
Code	*Percent*
1	0-1
2	2-5
3	6-25
4	26-50
5	51-75
6	76-95
7	96-100

Avg. Abundance of Berries on Stems (A)	
Code	*Abundance*
H	high
M	medium
L	low

TOTAL PERCENT COVER (TOT%COV.)

The total percent cover of all plants in each stratum (A0-Z) can be recorded in this row, right justified, in the shaded portion of the columns (i.e., columns 9 and 10, 13 and 14, etc.). This includes total cover for the categories Total Trees, Total Shrubs, and All Strata (see Figure 4.4). The total will be between the highest single coverage in a strata, and the sum of all species coverage in the stratum, or 100%, as a result of overlap with a stratum. A value of 99 is considered to adequately represent 100%. A decimal may be used (e.g., .2 for 0.2%).

Surveyors can also record the total percent cover of the Total Trees, Total Shrubs, C, and D layers in the first 12 columns of the "Plot Representing" item on the Site Description Form using 3 columns, right justified, for each value in the order above (trees, shrubs, C, D). These values can then be entered into The B.C. Soil Information System and extracted for summary tables.

STRATA HEIGHT (STRAT HT)

For each of the indicated strata (A0-C), record the actual upper height in metres in the "STRAT HT" row. This in not necessary for the Total Trees, Total Shrubs or All Strata categories. Heights as low as 0.01 m or 1 cm, and as high as 99.99 m can be coded.

DEAD TREES by strata

In addition to, or instead of recording dead trees by species in columns 57 to 60, they can be tallied by stratum and entered here. The number of dead trees should be entered right justified in the unshaded portion of the columns (e.g. columns 10 to 12).

COMMENTS

Space is provided for making any additional comments on the vegetation of the site. Examples include observations on insect damage, unusual growth forms of a species, and vegetation patterns reflecting microtopography. In addition, if special project specific codes are used in the stratum and/or entries area, they can be defined here.

KEYPUNCHING FORMS

The Vegetation Description Forms can be directly keypunched for computer entry provided they are completed correctly and neatly. Note that Series and Form No. are always numeric. "Stratum" is always one letter followed by either a blank or a number. "Entries" are always alphabetic characters. Any column containing data must be supported by an Entries character. Data in the main part of the form (columns 9-52) are always numeric, occasionally with a decimal. "TØT%CØV", "STRAT HT," with an assumed decimal, and "DEADTREE" are always numeric. "Comments" are entered in free format and may consist of letters, numbers, and special symbols. All letters anywhere on the form are in uppercase.

The Vegetation Description Form is designed to allow vegetation data to be entered into a computer data bank. Although a common vegetation data bank does not currently exist, there are a number of advantages in using the form and coding procedures: data can be exchanged with other surveyors and data do not have to be recoded before keypunching.

The B.C. Ministry of Forests has a program that converts data from the description form to a standard format for its data processing system. The program only reads the plot number and the species code and values in columns 9 through 52 and 71 and 72. Surveyors using the Ministry of Forests system should code "1" in column 1 after the last species entry for a plot; the computer uses this "flag" to read a new plot number.

If other data useful in a project are collected on the description form, programs will have to be written to read the data from the keypunch file and convert it to a format suitable for analysis.

FIELD ROUTINE

For detailed vegetation descriptions, it is important that the plot be assessed and the data form completed in a systematic manner. Outlined below is a possible sequence that might be followed.

1. Walk through the plot to check homogeneity and establish plot boundaries.
2. Complete the top portion of the Vegetation Description Form (Project I.D., Plot No., Series and Form Number, Surveyor, Page).
3. If Stratum or Entries have to be changed, specify and record the changes.
4. Walk the plot making mental notes of the species present.
5. Walk the plot again listing plants by stratum, starting with trees (A1, A2) and collecting specimens of unidentified plants as they are encountered.
6. Estimate and record percent cover, distribution, and vigour of each species in each of the strata and estimate totals where a species occurs in more than one stratum (i.e., Total Trees, Total Shrubs, and/or All Strata).
7. Estimate and record the height of each stratum in metres.
8. Estimate and record total percent cover for each stratum and combined strata (Total Trees, Total Shrubs, and All Strata).
9. List the species on atypical substrates and record their abundance.
10. Record phenology, dead trees, utilization, forage and any project specific information for each species if it is important to the project.
11. Check the plot for any additional species. Check the description form for coding errors and verify that the total cover of each stratum coincides with the sum of coverages of individuals in the stratum with respect to overlap.
12. Walk the plot once more to doubly ensure that the description form has been correctly completed.

CHAPTER 5

MENSURATION

MENSURATION FORM

FORM NUMBER

PROJECT I.D. ______________________ PLOT NO. ______________________ PAGE ________ OF ________

SURVEYOR ______________________

	PLOT NO.						BAF		D.B.H LIMIT
1	2	3	4	5	6	7	8	9	
C			A						

TREE NO	TOTAL HEIGHT (Meters)	SPECIES	D B H (Centimeters)	TREE CLASS	PATH REMARKS								CROWN CLASS
					CONK	BLIND CONK	SCAR	[illegible]	[illegible]	MISTLETOE	[illegible]	[illegible]	
	10 11 12	13 14	15 16 17 18		19	20	21	22	23	24	25	26	

STAND AGE (for MAI)		
78	79	80

TREE CLASS	
1	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	[illegible]

PATH CODE

CROWN CLASS (C/C)	
1	DOMINANT
2	CO-DOMINANT
3	INTERMEDIATE
4	SUPPRESSED

	PLOT NO.						BAF		D.B.H LIMIT
1	2	3	4	5	6	7	8	9	
C			B						

TREE NO	TOTAL HEIGHT (Meters)	SPECIES	D B H (Centimeters)	TREE CLASS	PATH REMARKS								CROWN CLASS
					CONK	BLIND CONK	SCAR	[illegible]	[illegible]	MISTLETOE	[illegible]	[illegible]	
	10 11 12	13 14	15 16 17 18		19	20	21	22	23	24	25	26	

STAND AGE (for MAI)		
78	79	80

TREE NO.	TOTAL HEIGHT	SPEC.	D.B.H.	C/C	TOTAL AGE	AGE CALCULATIONS				HEIGHT CALCULATIONS							
						COUNT. AGE	B.H.	COR.	SUP.	TOP	BOT.	TOTAL	S.D.	SLOPE	H.D.	HT.	COR.

F.S. 1086 M28-850

Chapter Five

MENSURATION

INTRODUCTION

The Mensuration Form deals with the measurement of trees. Transfer the Series and Form Number from the Site Description Form to the box at the upper right-hand corner of the Mensuration Form. Transfer also the project I.D. and Plot No. from the Site Description Form and enter them in the appropriate places. Surveyor is the name of the individual filling out the form.

The Mensuration Form is designed for recording data required for cruise plot volume calculations and sample tree data for site index calculations. The small numbers below Plot No., BAF, etc., on the form are used in transferring the data into a computer file.

In addition to the material presented here, surveyors will also require the site curves in the B.C. Ministry of Forests *Inventory Manual* (1985), or *Field Pocket Handbook* (1981b).

CRUISE INFORMATION — GENERAL

This chapter deals primarily with variable plot cruising (i.e., using prisms or Relaskops) to determine volume of timber. This method overcomes the two main disadvantages of fixed radius plots, namely, the time required for accurate plot boundary location and the intense sampling of small diameter trees. Two cruise plots (A and B) are recommended for each sample plot to allow for variability in tree distribution (see Figure 5.1).

Fixed plot sampling may be desirable when the stand is dominated by small diameter trees. If fixed plots are used, a number of factors will have to be considered in determining plot size and shape. For example, the coefficient of variation decreases as plot size is increased. Circular plots are generally more efficient, since there are fewer "line" trees than in a rectangular plot of similar area. See the cruising manual (B.C. Ministry of Forests, 1984) for a short discussion of fixed plot sampling.

All measurements should be metric. A cruise plot compilation program is available through Systems Services, B.C. Ministry of Forests. For further information or plot cruising, contact the Research Branch, B.C. Ministry of Forests, Victoria.

LOCATING CRUISE PLOT CENTRES

The cruise plot centres must be located randomly; avoid the tendency to place them in convenient openings. The recommended method where a soil pit is also described is to use 3-digit random number tables (ignoring numbers greater than 360) to obtain a random azimuth direction from the soil pit. A pre-selected and constant number of paces (e.g., seven) should then be taken in the indicated direction to reach the centre of Plot A. Plot B would then be located 14 paces in the opposite direction (see Figure 5.2). If the distinctive ecosystem (plant community/soil) being sampled is linear in its occurrence, an appropriate azimuth can be selected and the number of paces chosen randomly.

If random number tables are not available, an alternative method is to stand at the soil pit and turn a compass dial approximately three times without looking. The bearing thus obtained should be the direction of travel from the soil pit to Plot A. Similar to above, Plot B would be located in the opposite direction.

If the distinctive plant community/soil being sampled is small, the number of paces can be lessened to ensure that the cruise plots still lie within the type being described. However, the direction of travel must still be determined in a random manner. Overlap of trees occurring in two plots must be avoided whenever possible. Assuming the plant community/polypedon is extensive enough, the number of paces from the soil pit should be increased to eliminate overlapping trees. On sites where the overlap cannot be limited to two trees or less, only one cruise plot should be measured. This can be checked by doing a quick sweep with the prism or Relaskop before beginning to tag the trees. In cases where overlap cannot be avoided (e.g., a small diameter stand containing a large veteran), ensure that if the overlapping trees are sample trees, they are recorded only once under "Sample Tree Information".

If a plot is highly variable in tree distribution (i.e., "clumpy"), and it appears that two plots will not adequately sample the variability, a third plot may be established in a direction perpendicular to the line between A and B (see Figure 5.3). In this instance, a second Mensuration Form will be required; be sure to enter the appropriate form number.

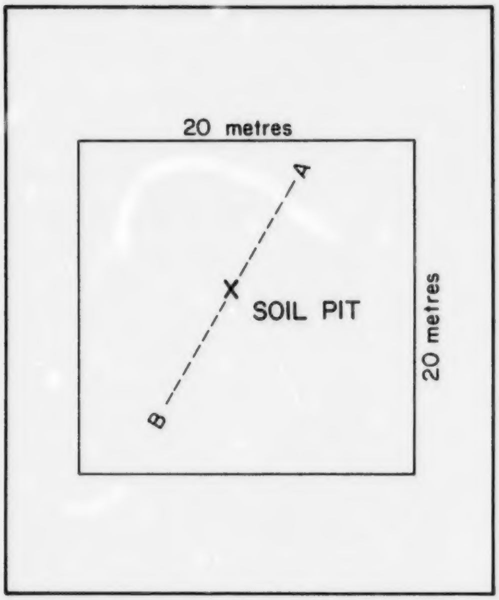

20 metres
20 metres
A
X
SOIL PIT
B

Figure 5.1 Relationship of cruise plot to sample plot and soil pit

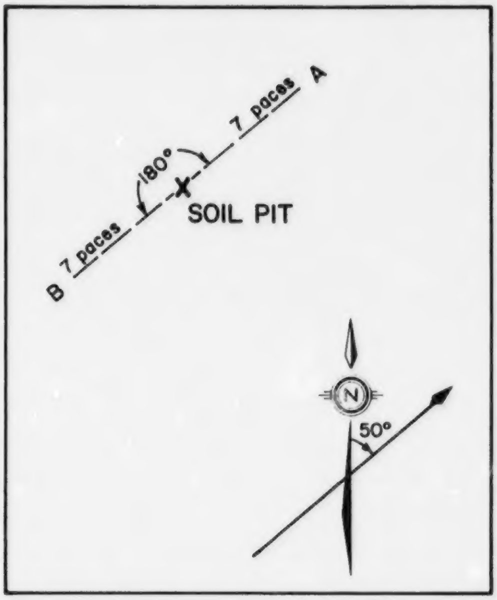

7 paces
A
180°
X
SOIL PIT
B
7 paces
N
50°

Figure 5.2 Location of cruise plot centre

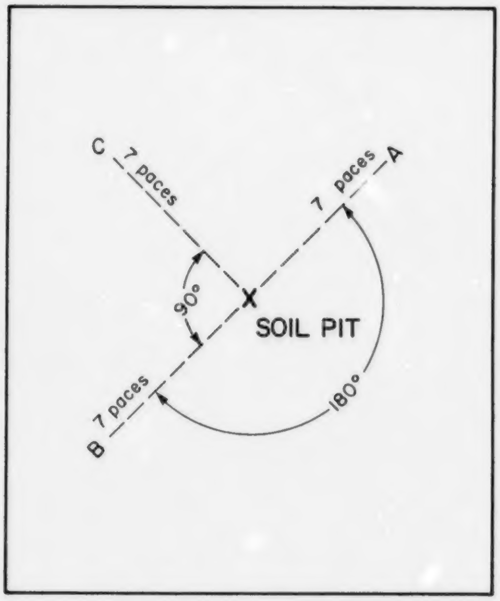

C
7 paces
7 paces
A
90°
X
SOIL PIT
7 paces
B
180°

Figure 5.3 Location of third cruise plot centre

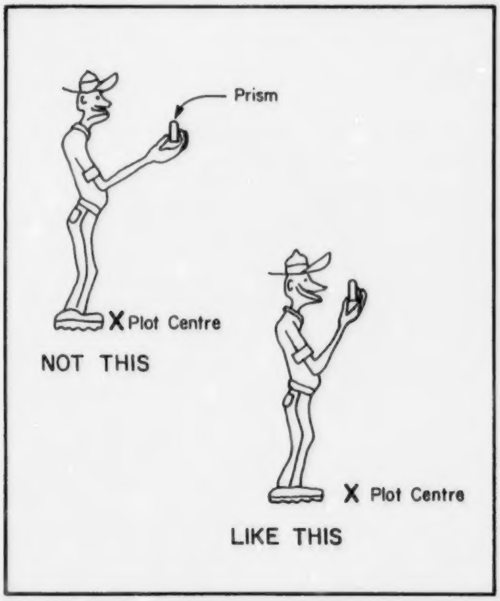

Prism
X Plot Centre
NOT THIS
X Plot Centre
LIKE THIS

Figure 5.4 How to hold a prism

TREE MEASUREMENTS — GENERAL

All coniferous and deciduous trees must be tallied if they occur in a cruise plot, are greater than 7.5 cm diameter at breast height (DBH is 1.3 m above ground), and are: living (both standing and down), dead useless, dead potential standing, or dead potential down (see "Tree Class").

The assigned tree number, species, DBH, tree class, pathological remarks, and crown class should be recorded for each tree in the cruise plot. Tree height estimates may also be recorded.

From the trees tallied, sample trees are chosen whose age and height is measured. At least two sample trees of each species should be chosen. These ideally should be Class 1 (i.e., no pathological indicators, see "Path Remarks"), thrifty mature (i.e., 80-140 years old), and crown class 1 or 2 (dominants or codominants). Where trees meeting these criteria do not occur within the plot, sample trees located outside the plot can be chosen, but they *must* be growing in the same plant community and on the same soil as those being described. If no trees meeting the criteria occur, discretion must be used in choosing the best alternate specimens.

Depending on the method employed for estimating or calculating the remaining tree heights, additional measured heights may be required (see "Total Height").

USE OF PRISMS

The following is a list of 'do's and do not's' when using prisms:

1. The prism must be held over the plot centre. The distance from eye to prism is irrelevant (Figure 5.4).
2. The prism must be aligned at right angles — the line of sight and the vertical and horizontal edges of the prism must form right angles (Figure 5.5).
3. Consistent deflection (either right or left) is preferrable, although it may be necessary to reverse the prism if a tree is difficult to see (Figure 5.6).
4. The top edge of the prism (the curved edge) must be aligned on the tree at breast height (1.3 m). This is where the reading is taken (Figure 5.7).
5. If the tree is leaning sideways, rotate the prism until the base of the prism is at right angles with the tree stem at breast height (Figure 5.8).
6. If the tree is leaning toward or away from plot centre, and is close to being borderline, it should be checked to determine if it is in or out of the plot. The horizontal distance is still measured from plot centre to the centre of the trunk at breast height (Figure 5.9).
7. If a tree is down, measure the diameter at 1.3 m, then hold the tape up to represent the tree while standing at the base of the tree to simulate its' former standing location (Figure 5.10).
8. If the tree is located on a slope greater than 20%, a slope correction must be made:
   (i) using a clinometer or Abney level, take a slope reading (at eye level) on the tree.
   (ii) with the clinometer facing you, place the prism on top of it and rotate it until the slope from (i) reads on the facing scale; make sure the units of slope are the same. Keep the top edge of the prism at 1.3 m on the tree (Figure 5.11).
9. Be sure to include trees that they are hidden or obscured by brush or other trees. It is permissible to move from plot centre, keeping a constant distance from the tree in question (Figure 5.12). If the tree is still not visible, it must be treated as a borderline tree.
10. *Always* measure borderline trees. For each Basal Area Factor (BAF), a tree of a given diameter has a particular plot radius, given in the Plot Radius Factor (PRF) tables. One example PRF table is Table 5.1 for BAF = 4. Plot Radius Factor tables for other BAF's are available from forestry supply stores (or from the B.C. Ministry of Forests' (1981b) *Field Pocket Handbook* for BAF's using the Relaskop). To determine whether a tree is in or out of the plot when it appears borderline, apply the following procedure:
    (i) measure the tree diameter at breast height (e.g., DBH = 50 cm);
    (ii) measure the horizontal distance from plot centre to the centre of the tree trunk at breast height (1.3 m). If the slope is greater than 20% a slope correction will be required (see "Height Calculations"). For example, horizontal distance = 13 m.
    (iii) refer to the appropriate PRF table. If the plot radius (or horizontal limiting distance) for that tree diameter exceeds the measured distance, the tree is "in". If the measured distance exceeds the distance in the table, the tree is "out". With a DBH of 50 cm and a horizontal distance of 13 m, the tree is "out" and is not to be included.

Be sure to use the appropriate PRF factor (Table 5.2) for the BAF being used, and that the units of measurement are consistent (i.e., metres — centimetres, or feet — inches).

The horizontal limiting distance (HLD) can be easily calculated without a PRF table as follows:

$HLD\ (m) = DBH\ (cm) \times$ plot radius factor (PRF), where $PRF = 0.5 \div (BAF)^{0.5}$

A tree is "in" if the horizontal distance (HD) to the tree is less than the horizontal limiting distance (HLD). Using the above example:

$BAF = 4\ DBH = 50\ cm\ HD = 13m$

$PRF = 0.5 \div (4)^{0.5} = 0.25$

$HLD = 50 \times 0.25 = 12.5\ m$

The tree is "out" because the horizontal distance is greater than the horizontal limiting distance.

Table 5.2 gives plot radius factors (PRF) for metric prisms.

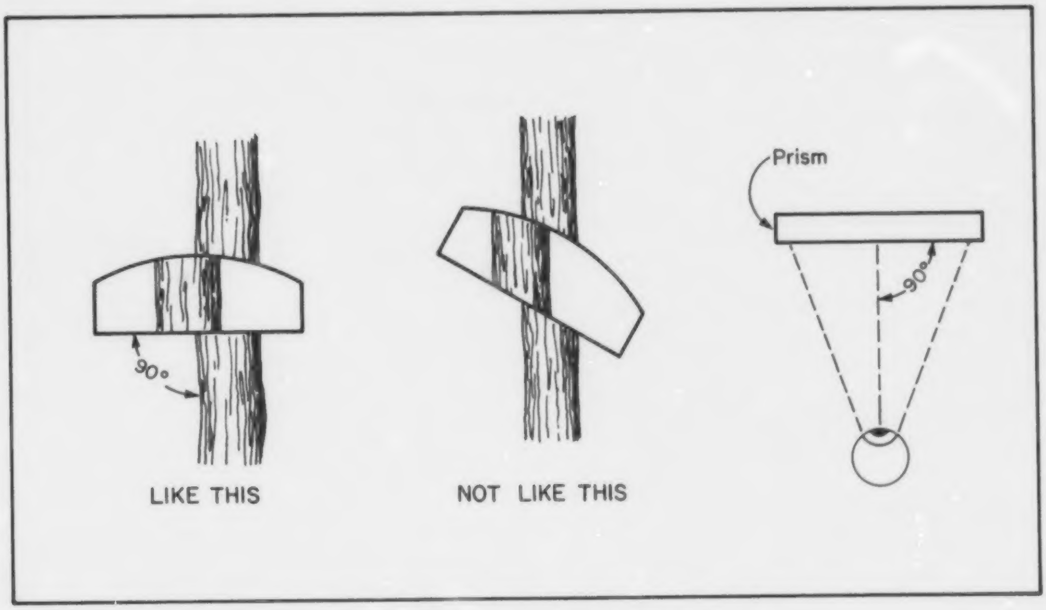

Prism
90°
90°
LIKE THIS
NOT LIKE THIS

Figure 5.5 Alignment of prism to tree

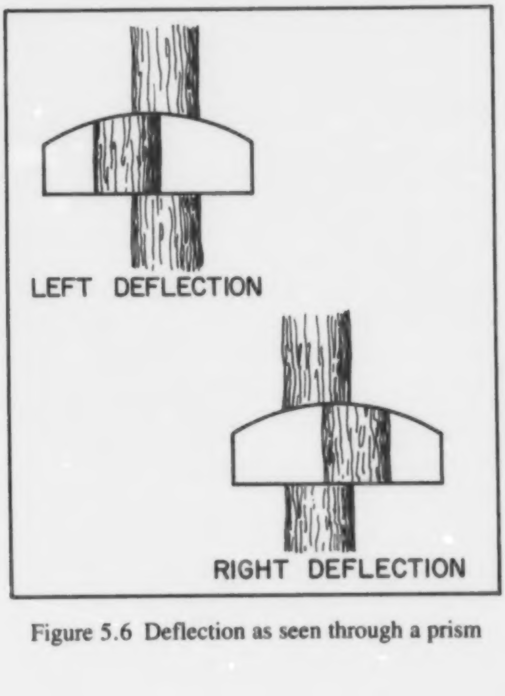

LEFT DEFLECTION
RIGHT DEFLECTION

Figure 5.6 Deflection as seen through a prism

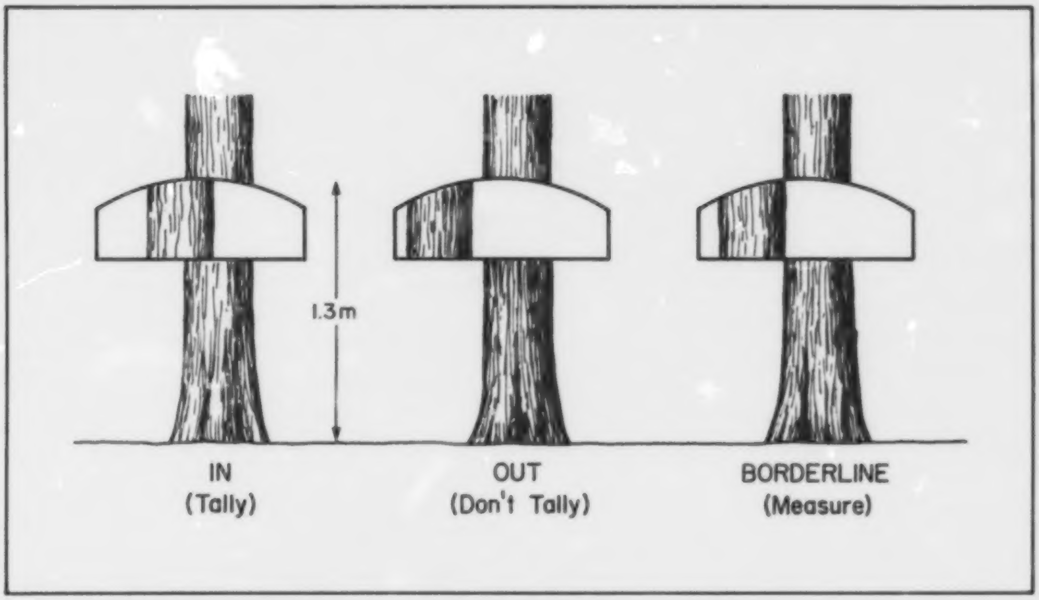

1.3m
IN
(Tally)
OUT
(Don't Tally)
BORDERLINE
(Measure)

Figure 5.7 How to determine in, out, and borderline trees when using prisms

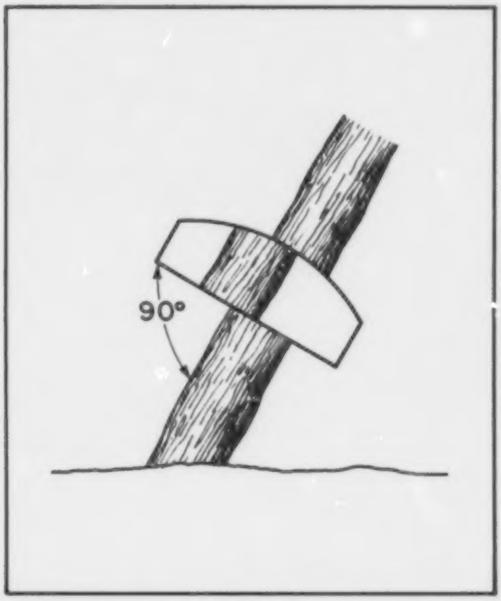


Figure 5.8 Alignment of prism for leaning trees

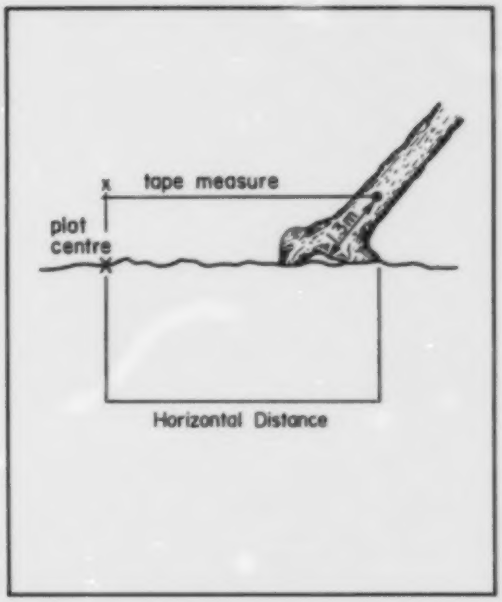

x
tape measure
plot
centre
1.3m
Horizontal Distance

Figure 5.9 How to check a borderline tree that is leaning

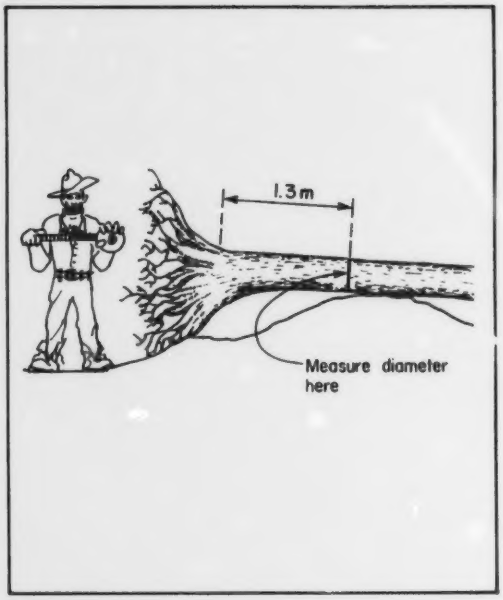

1.3m
Measure diameter
here

Figure 5.10 How to cruise a downed tree

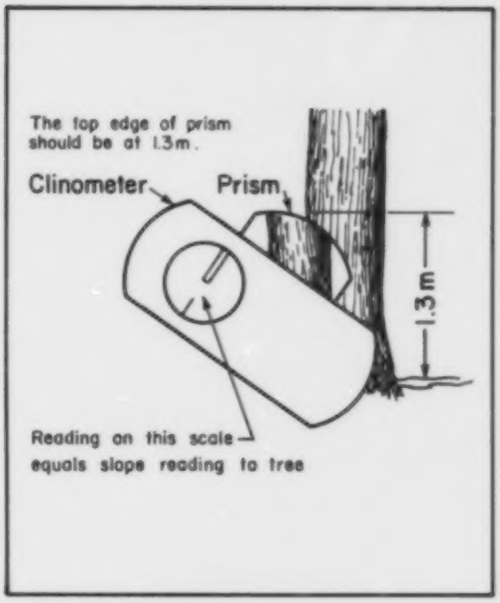

The top edge of prism
should be at 1.3m.
Clinometer
Prism
1.3m
Reading on this scale
equals slope reading to tree

Figure 5.11 How to cruise a tree when slope of ground is greater than 20 percent

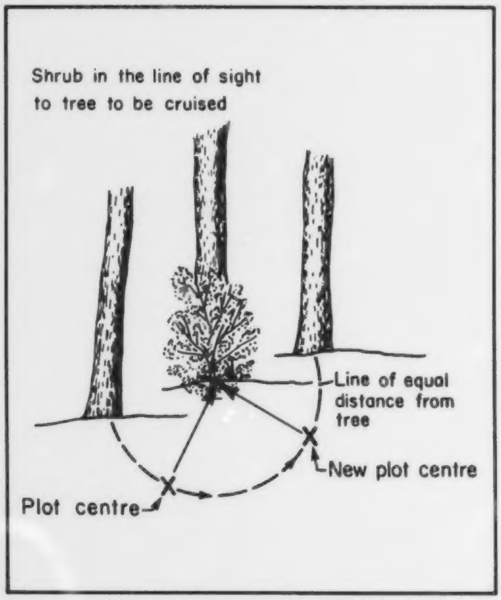

Shrub in the line of sight
to tree to be cruised
Line of equal
distance from
tree
New plot centre
Plot centre

Figure 5.12 How to move the plot centre when line of site is obscured

Table 5.1 Example of a plot radius factor (PRF) table* (Maximum horizontal distance in metres from plot center for trees of a given diameter)

2 BANDS B.A.F. = 4

Diameter (cm)

D.B.H. cm	.0	.2	.4	.6	.8
7			1.85	1.90	1.95
9	2.25	2.30	2.35	2.40	2.45
11	2.75	2.80	2.85	2.90	2.95
13	3.25	3.30	3.35	3.40	3.45
15	3.75	3.80	3.85	3.90	3.95
17	4.25	4.30	4.35	4.40	4.45
19	4.75	4.80	4.85	4.90	4.95
21	5.25	5.30	5.35	5.40	5.45
23	5.75	5.80	5.85	5.90	5.95
25	6.25	6.30	6.35	6.40	6.45
27	6.75	6.80	6.85	6.90	6.95
29	7.25	7.30	7.35	7.40	7.45
31	7.75	7.80	7.85	7.90	7.95
33	8.25	8.30	8.35	8.40	8.45
35	8.75	8.80	8.85	8.90	8.95
37	9.25	9.30	9.35	9.40	9.45
39	9.75	9.80	9.85	9.90	9.95
41	10.25	10.30	10.35	10.40	10.45
43	10.75	10.80	10.85	10.90	10.95
45	11.25	11.30	11.35	11.40	11.45
47	11.75	11.80	11.85	11.90	11.95
49	12.25	12.30	12.35	12.40	12.45
51	12.75	12.80	12.85	12.90	12.95
53	13.25	13.30	13.35	13.40	13.45
55	13.75	13.80	13.85	13.90	13.95
57	14.25	14.30	14.35	14.40	14.45
59	14.75	14.80	14.85	14.90	14.95
61	15.25	15.30	15.35	15.40	15.45
63	15.75	15.80	15.85	15.90	15.95
65	16.25	16.30	16.35	16.40	16.45
67	16.75	16.80	16.85	16.90	16.95
69	17.25	17.30	17.35	17.40	17.45
71	17.75	17.80	17.85	17.90	17.95
73	18.25	18.30	18.35	18.40	18.45
75	18.75	18.80	18.85	18.90	18.95
77	19.25	19.30	19.35	19.40	19.45
79	19.75	19.80	19.85	19.90	19.95
81	20.25	20.30	20.35	20.40	20.45
83	20.75	20.80	20.85	20.90	20.95
85	21.25	21.30	21.35	21.40	21.45
87	21.75	21.80	21.85	21.90	21.95
89	22.25	22.30	22.35	22.40	22.45
91	22.74	22.79	22.84	22.89	22.94
93	23.24	23.29	23.34	23.39	23.44
95	23.74	23.79	23.84	23.89	23.94
97	24.24	24.29	24.34	24.39	24.44
99	24.74	24.79	24.84	24.89	24.94

Diameter (cm)

D.B.H. cm	.0	.2	.4	.6	.8
8	2.00	2.05	2.10	2.15	2.20
10	2.50	2.55	2.60	2.65	2.70
12	3.00	3.05	3.10	3.15	3.20
14	3.50	3.55	3.60	3.65	3.70
16	4.00	4.05	4.10	4.15	4.20
18	4.50	4.55	4.60	4.65	4.70
20	5.00	5.05	5.10	5.15	5.20
22	5.50	5.55	5.60	5.65	5.70
24	6.00	6.05	6.10	6.15	6.20
26	6.50	6.55	6.60	6.65	6.70
28	7.00	7.05	7.10	7.15	7.20
30	7.50	7.55	7.60	7.65	7.70
32	8.00	8.05	8.10	8.15	8.20
34	8.50	8.55	8.60	8.65	8.70
36	9.00	9.05	9.10	9.15	9.20
38	9.50	9.55	9.60	9.65	9.70
40	10.00	10.05	10.10	10.15	10.20
42	10.50	10.55	10.60	10.65	10.70
44	11.00	11.05	11.10	11.15	11.20
46	11.50	11.55	11.60	11.65	11.70
48	12.00	12.05	12.10	12.15	12.20
50	12.50	12.55	12.60	12.65	12.70
52	13.00	13.05	13.10	13.15	13.20
54	13.50	13.55	13.60	13.65	13.70
56	14.00	14.05	14.10	14.15	14.20
58	14.50	14.55	14.60	14.65	14.70
60	15.00	15.05	15.10	15.15	15.20
62	15.50	15.55	15.60	15.65	15.70
64	16.00	16.05	16.10	16.15	16.20
66	16.50	16.55	16.60	16.65	16.70
68	17.00	17.05	17.10	17.15	17.20
70	17.50	17.55	17.60	17.65	17.70
72	18.00	18.05	18.10	18.15	18.20
74	18.50	18.55	18.60	18.65	18.70
76	19.00	19.05	19.10	19.15	19.20
78	19.50	19.55	19.60	19.65	19.70
80	20.00	20.05	20.10	20.15	20.20
82	20.50	20.55	20.60	20.65	20.70
84	21.00	21.05	21.10	21.15	21.20
86	21.50	21.55	21.60	21.65	21.70
88	22.00	22.05	22.10	22.15	22.20
90	22.50	22.55	22.60	22.65	22.70
92	22.99	23.04	23.09	23.14	23.19
94	23.49	23.54	23.59	23.64	23.69
96	23.99	24.04	24.09	24.14	24.19
98	24.49	24.54	24.59	24.64	24.69
100	24.99	25.04	25.09	25.14	25.19

* PRF tables are available from the Inventory Branch, Ministry of Forests for other BAF prisms.

Table 5.2 Plot radius factors (PRF) for prisms of various basal area factors (BAF)

Basal Area Factor (BAF) m^2/ha	**Plot Radius Factor (PRF)**	**Basal Area Factor (BAF) m^2/ha**	**Plot Radius Factor (PRF)**
1	0.500	7	0.189
2	0.354	8	0.177
3	0.289	9	0.167
4	0.250	10	0.158
5	0.224	11	0.151
6	0.204	12	0.144

USE OF THE RELASKOP

All of the previous suggestions for prism measurements also apply to the Relaskop, except that the latter has a built-in mechanism for slope correction. An image viewed through a Relaskop is simulated in Figure 5.13. The tree shown would be "in" for BAF 5 to 10, and "out" for BAF 20. Be sure to align the left edge of the tree with the "O" line.

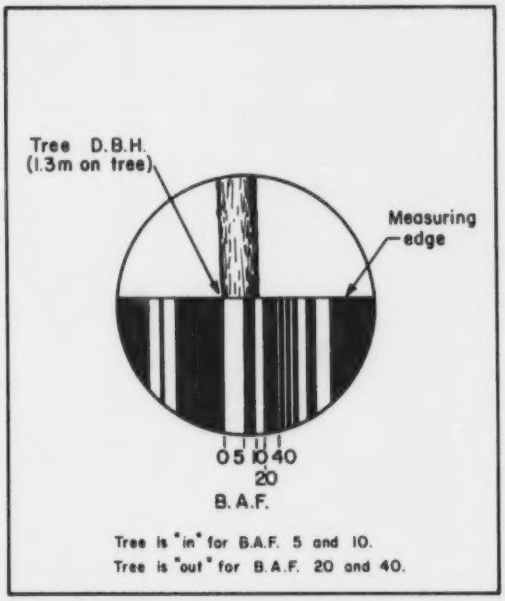

Tree D.B.H. (1.3m on tree)
Measuring edge
0 5 10 40
20
B.A.F.
Tree is "in" for B.A.F. 5 and 10.
Tree is "out" for B.A.F. 20 and 40.

Figure 5.13 How to use the Relaskop

CHOOSING THE BASAL AREA FACTOR (BAF)

Standard metric Basal Area Factor (BAF) prisms are now available and in use. With the conversion to metric measurement, only BAF sizes approved by the B. C. Ministry of Forests should be used. During the transition, Imperial BAF sizes can be used with other measurements being in metric, but Plot Radius Factor (PRF) tables must be adapted.

The number of trees in a plot vary with the BAF used. The optimum number of trees (over 7.5 cm DBH) per plot is from 7 to 11; the minimum and maximum are 5 and 16, respectively. The BAF size must therefore be selected to provide this number of trees in the plot. Generally speaking, the larger the trees, the larger the BAF, and the denser the stand, the smaller the BAF. Initially, it may be necessary to stand at plot centre and do quick sweeps to roughly determine the number of trees with the various BAF sizes. With experience, this trial-and-error becomes less necessary.

Samples that include a small number of trees per point result in extremely high sample variance. As the number of trees increase, however, a point is reached where a further decrease in BAF and a corresponding increase in the count results in only a slight gain in precision. It appears that if a sample contains more than 16 trees, it is statistically inefficient because it only repeats the information that could have been obtained from a smaller sampling unit.

In stands of two distinct layers or where, for some other reason, the desired number of trees cannot be obtained, the following procedure *must* be followed. Using two different BAF sizes, do one full sweep with the larger BAF, tallying only those trees between 7.5 and 27.4 cm DBH, and a second full sweep with the smaller BAF, tallying only those trees greater than 27.5 cm DBH. The total number of trees tallied must still lie within the 5 to 16 tree limit. The choice of BAF's, therefore, is still critical and will require some trial-and-error attempts in this more complex situation.

The same prism size must be used for all samples within a forest type (sample plot).

PLOT INFORMATION

The Mensuration Form consists of "plot information", located in two adjacent boxes in the upper part of the form, and "sample tree information" located in the box rear the bottom. Items relating to plot information are explained first.

Plot No.

The coding format is open but the following is suggested:

column 1 — fixed as C for computer program
columns 2-3 — year of sampling, or series number from Site Description Form (e.g., 87)
column 4 — fixed as A or B for the two cruise plots
columns 5-7 — the last three unique digits of the form number (e.g., for form number 12345, record 345 in columns 5-7).

BAF

Record in columns 8 and 9, right justified, the metric basal area factor (BAF).

DBH Limit

Record the lower diameter limit (usually 7.5 cm) for Diameter Breast Height (DBH) to one decimal place.

Tree No.

Number the trees consecutively, with no duplication. Trees should be marked with their numbers by felt pen on flagging tape or stapled-on numbered tags. Enter the numbers right justified in the form.

Total Height

The total height of sample trees is transferred up from the "Total Height" column in the "Sample Tree Information" box at the bottom of the form (explained later). The heights of other trees, including 'dead useless' and 'dead potential', can either be estimated in the field or derived from height-diameter relationship regression equations based on sample tree measurements. On-site estimation of height is preferred since the accuracy of computed height-diameter relationships is sometimes questionable. This is especially true in stands where normal height-diameter relationships clearly do not apply; for example, high elevation stands with large diameter trees that have not attained a correspondingly tall height because of snow and wind breakage. In these situations, heights must be estimated for all trees.

When assessing heights of trees with broken tops, the full height prior to breakage should be estimated and recorded to facilitate gross volume calculations. Appropriate volume reductions will be made from the pathological information during calculation of net volume. If height-diameter curves are used, they will automatically provide the full tree height, subject to the same error as stated previously.

As mentioned before, it is recommended that field estimates of heights be made wherever possible, rather than relying on computed height-diameter relationships. If the latter method is used, it will be necessary to ensure that sample trees cover the full range of diameters and heights for each species. A recommended distribution is 1/4 dominants, 1/2 co-dominant, and 1/4 intermediate. The minimum number of sample trees for each species is 30, if valid height-diameter relationships are to be obtained. Refer to the B.C. Ministry of Forests (1984) cruising manual for further information.

Species

Record the appropriate tree species symbols, as indicated in Table 5.3.

Table 5.3 Tree species codes to be used on mensuration form

Species	Common Name	Symbol
Abies amabilis	amabilis fir	Ba
A. grandis	grand fir	Bg
A. lasiocarpa	subalpine fir	Bl
Acer macrophyllum	bigleaf maple	Mb
Alnus rubra	red alder	Dr
Betula neoalaskana	Alaska paper birch	Ea
B. papyrifera	paper birch	Ep
B. occidentalis	water birch	Ew
Chamaecyparis nootkatensis	yellow-cedar	Yc
Larix lyallii	alpine larch	La
L. laricina	tamarack	Lt
L. occidentalis	western larch	Lw
Picea mariana	black spruce	Sb
P. engelmannii	Engelmann spruce	Se
P. sitchensis	Sitka spruce	Ss
P. glauca	white spruce	Sw*
Pinus albicaulis	whitebark pine	Pa
P. flexilis	limber pine	Pf
P. banksiana	jack pine	Pj
P. contorta	lodgepole pine	Pl
P. monticola	western white pine	Pw
P. ponderosa	yellow pine	Py
Populus balsamifera	poplar	Ac**
P. tremuloides	trembling aspen	At
Pseudotsuga menziesii	Douglas-fir	Fd
Thuja plicata	western redcedar	Cw
Tsuga mertensiana	mountain hemlock	Hm
T. heterophylla	western hemlock	Hw

* Sx can be used for hybrid spruce.
** includes both balsam poplar (subsp. *balsamifera*) [Acb], and black cottonwood (subsp. *trichocarpa*) [Act].

DBH

DBH (Diameter Breast Height) is recorded to the nearest 0.1 cm. The small black circle on the form is the decimal point. Diameter should be measured at breast height which is defined as 1.3 m above the point of germination. The location of the point of germination is illustrated in Figure 5.14.

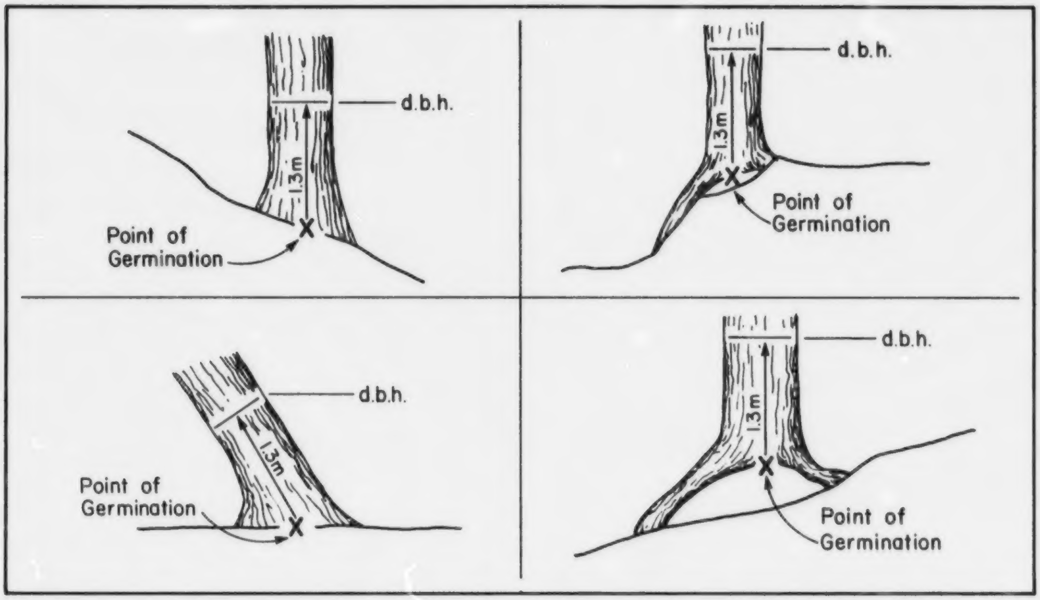


Figure 5.14 DBH in relation to point of germination

Tree Class

Enter the appropriate pathological tree class number from the box in the centre of the data form. Definitions of the tree class numbers follow.

Code	*Tree Class*
1	Residual — living trees with none of the eight pathological indicators.
2	Suspect — living trees with one or more pathological indicators.
3	Dead Potential — dead, standing, or down wood, estimated to contain at least 50% by volume in soundwood content and is potentially useful (i.e., this wood would be extracted with other merchantable material).
4	Dead Useless — dead, standing trees that have no potential merchantable use. They are recorded to indicate snag density in the stand. Only trees over 7.5 cm DBH and 3 m high should be tallied.
5	Veteran — a mature, living tree 121 years or older and at least 40 years older than the main stand which must be younger than 120 years (e.g., a 150-year-old Douglas-fir in a stand of 80-year-old lodgepole pine).

Path. Remarks

Refer to the small box entitled "Path. Code" in the centre of the data form. It indicates the numerical coding to be used in this section. The "Path. Code" box has three columns, with the left-hand column representing the lower third of the tree, the middle column the middle third, and the right-hand column the upper third of the tree. The shading in the columns on the data form indicates in which portion of the tree the defects occur. The applicable numerical codes are shown to the left of the columns and are defined as follows:

Code	*Defect Occurrence on Tree*
1	lower third only
2	middle third only
3	upper third only
4	lower and middle thirds
5	middle and upper thirds
6	lower and upper thirds
7	entire tree

The column headings under “PATH. REMARKS” are self-explanatory except for: “Rotten Br.” which means “Rotten Branch”, and “D or B Top” which means “Dead or Broken Top”. All the characteristics listed must be noted where they occur, including “Dead or Broken Top”. The last portion of this chapter (Pathological Indicators) describes each of these conditions.

EXAMPLES:

1. A tree has conks on the middle and upper thirds of the trunk and an open basal scar on the lower third. Under “Conk” enter “5” and under “Scar” enter “1”.
2. A tree has a fork in the middle third, blind conks on the upper third, and a broken top. Under “Fork” enter “2”, under “Blind Conk” enter “3”, and under “D or B Top” enter “3”.
3. A tree has a fork in the middle third, with a frost crack extending from the ground to the fork; one of the leaders of the fork is broken. Under “Fork or Crook” enter “2”, under “Frost Crack” enter “4”, and under “D or B Top” enter “3”.

Every tree must be viewed from all sides before it is classified as Residual or Suspect. Look for suspect characteristics at the base and on lowest third of the tree first, then move back and around the tree, noting the location of other suspect characteristics on the middle and uppermost thirds. Tree classification is an essential part of sampling and the time spent is well justified. Refer to “Pathological Indicators” at the end of this chapter for diagrams and further information about residual and suspect trees.

Crown Class

Enter the crown class for the tree by number code, as shown in the box in the middle of the Mensuration Form. Figure 5.15 illustrates the general relationship between crown classes.

1. Dominant (D) — trees with crowns extending above the general level of the crown canopy.
2. Co-dominant (C-D) — trees with crowns forming the general level of the crown canopy. The crown is generally smaller than that of a dominant tree and usually more crowded on the sides.
3. Intermediate (Int.) — trees with crowns below, but still extending into, the general level of the canopy. The crowns are usually small and quite crowded on the sides.
4. Suppressed (S) — trees with crowns entirely below the level of the canopy.

Stand Age (for MAI)

Mean annual increment (MAI) can only be calculated for relatively even-aged, thrifty mature stands. As a general rule, ages of sample trees should vary by less than 20 years and the stand age should be between 60 and 200 years. As well, the sample trees must be representative of the stand as a whole. For example, if the sample trees have diameters of approximately 35 cm and the stand as a whole has diameters in the range of 80-90 cm, MAI cannot be accurately calculated. Where the stand meets the correct criteria, record right justified, the average age of the sample trees in columns 78-80. If nothing is recorded, MAI will not be calculated.

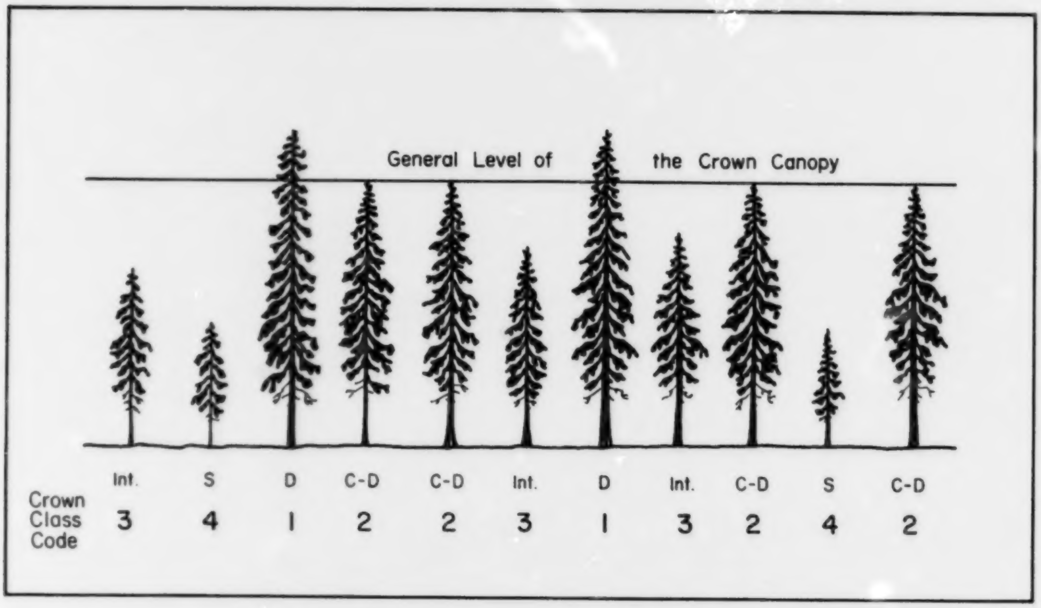

General Level of the Crown Canopy
Int.
S
D
C-D
C-D
Int.
D
Int.
C-D
S
C-D
Crown Class Code
3
4
1
2
2
3
1
3
2
4
2

Figure 5.15 Explanatory diagram of crown class

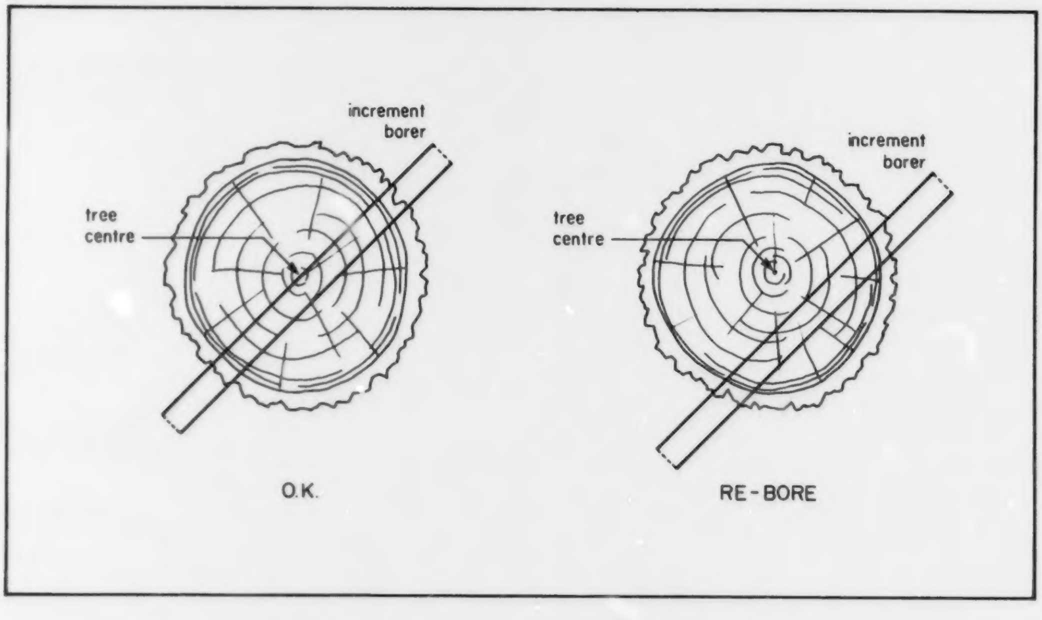

increment borer
tree centre
O.K.
increment borer
tree centre
RE-BORE

Figure 5.16 Alignment of increment borer with tree centre

SAMPLE TREE INFORMATION

Tree No.

Sample tree information should be recorded in the large box near the bottom of the Mensuration Form. Refer to "Tree Measurements -General" for a discussion of sample trees.

"Tree No." refers to the number assigned to the tree in the plot. The number is recorded right justified with the plot letter (A or B) shown first; for example, A01, B11, etc. If the tree is located outside the plot, use 99, 98, 97, etc., with no plot letter.

Total Height

Total height is determined by adding "HT." and "COR.", under "Height Calculations" on the form, to one decimal place (in metres).

Spec. (Species)

The species of the sample tree is recorded here. The appropriate symbols are shown in Table 5.3.

DBH

As previously explained, DBH is recorded to nearest 0.1 cm. Remember to measure the DBH of trees located outside the plot, if they are used as sample trees.

Total Age

Total age is determined by adding "COUNT. AGE" and "COR.", under "Age Calculations" on the form.

Age Calculations

COUNT. AGE (counted age)

The counted age refers to the number of rings counted in a sample core. The pith counts as one year, and the sample core must lie within three years of the pith (Figure 5.16).

B.H. (boring height)

Boring height refers to the height above the ground at which the sample core is extracted. Bore as low as possible and at one of the following heights to correspond to the heights used in the age correction tables (Figure 5.17): 0.3, 0.6, 0.9, 1.2, or 1.5 m.

COR. (correction)

This item is a correction added to the counted age to account for the number of years the tree took to grow to the boring height, since counted age only reflects growth past this age. Age correction tables and site curves are used to determine the correction. Because the corrections are averages, the size of a possible error is reduced if the boring height is kept as low as possible. Age correction tables for each tree species are contained on site curves (e.g., see Figure 5.17) available from B.C. Ministry of Forests' (1981a and 1981b).

SITE INDEX EQUATIONS AND CURVES

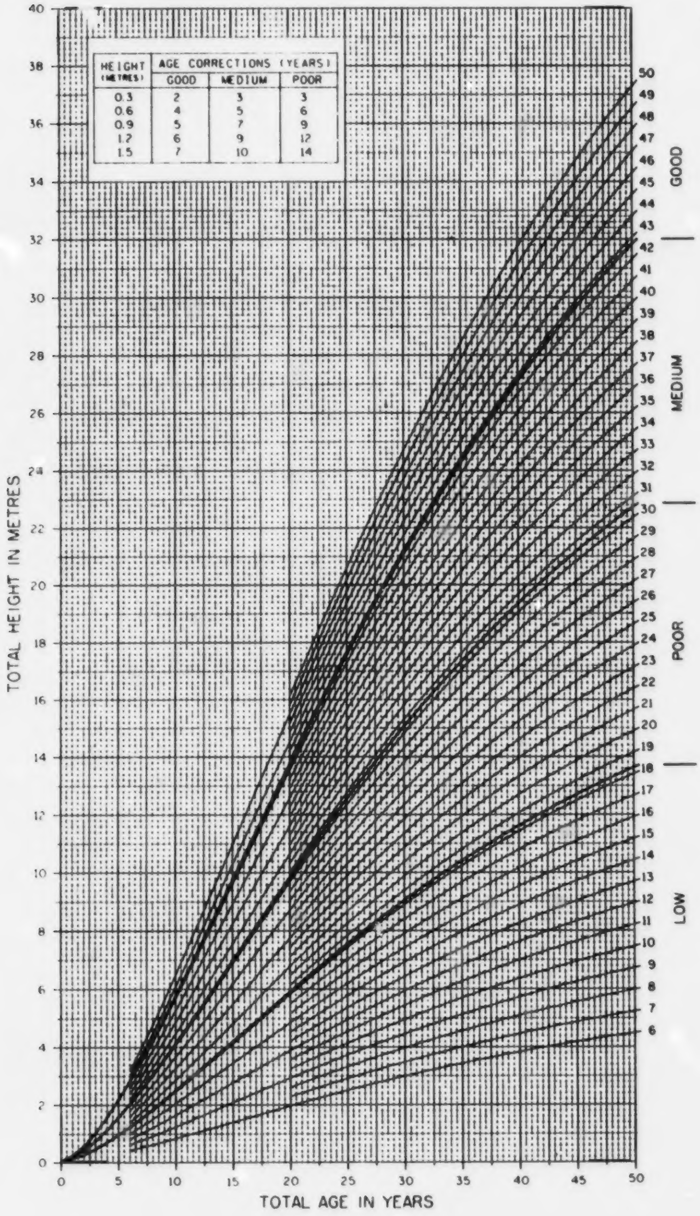
Pseudotsuga menziesii (COAST) DOUGLAS FIR

REFERENCE AGE 100

EQUATION: HT=B(1) * SI * (1.0 - EXP(B(2) * A)) ** B(3)

B(1)= 1.0694 B(2)= -.0319 B(3)= 1.5967

SITE: LOW < 18.30 < POOR < 30.50 < MEDIUM < 42.70 < GOOD



HEIGHT (METRES)	AGE CORRECTIONS (YEARS)		
	GOOD	MEDIUM	POOR
0.3	2	3	3
0.6	4	5	6
0.9	5	7	9
1.2	6	9	12
1.5	7	10	14

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INVENTORY BRANCH OCT-79

Figure 5.17 Site index equations and curves for *Pseudotsuga menziesii* (COAST). Douglas-fir reference age 100. Lower Curve

SITE INDEX EQUATIONS AND CURVES

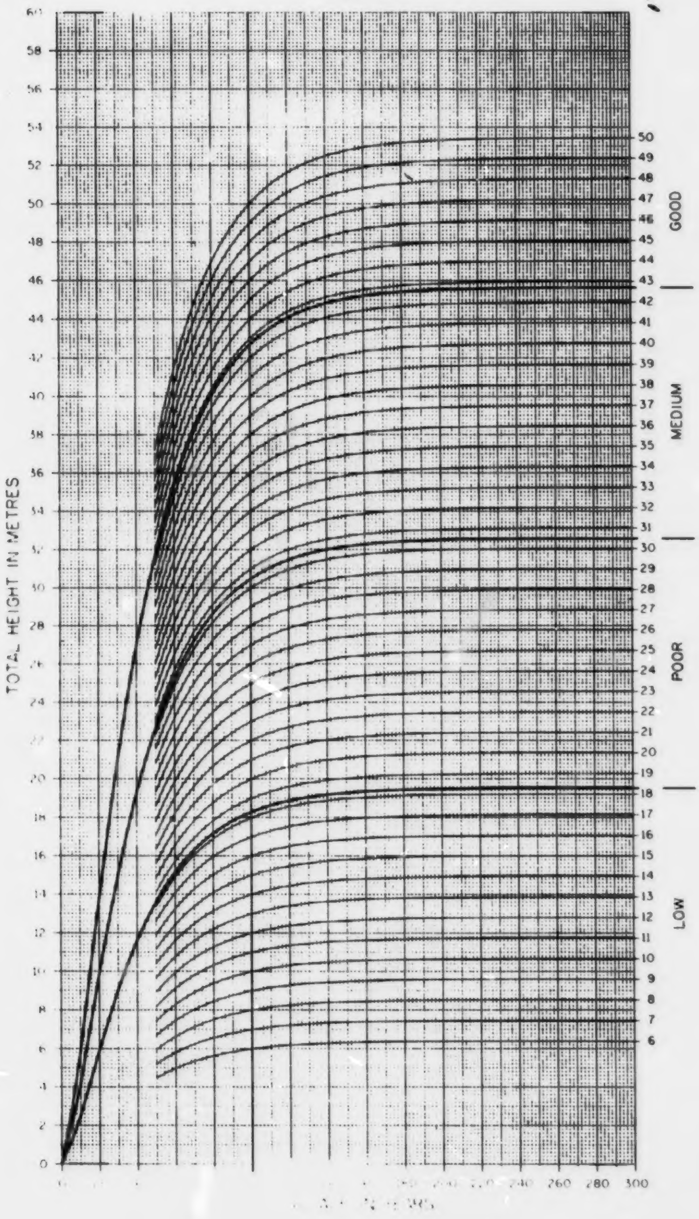
Pseudotsuga menziesii (COAST) DOUGLAS FIR

REFERENCE AGE 100

EQUATION: HT ... = SI * ...0 EXP(B(2) * A)) ** B(3)

B(1) = 1.0694 B(2) = -.0319 B(3) = 1.5967

SITE LOW = 18.30 POOR = 30.50 MEDIUM = 42.70 = GOOD



MINISTRY OF FORESTS
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Figure 5.17 (*continued*) Site index equations and curves for *Pseudotsuga menziesii* (COAST). Douglas-fir reference age 100. Upper Curve

SUP. (suppression)

This item records the number of years the sample tree was initially suppressed through competition and crowding by mature trees. The number of very tightly packed rings near the pith reveal the duration. This important piece of information gives a truer idea of potential growth on the site when competition from older trees is not present; for example, after clearcut logging.

Two examples for calculating Total Age follow:

1. tree species: Coast Douglas-fir
   counted age: 98 yrs.
   B.H.: 0.3 m
   total height: 26.2 m
   site class (from Figure 5.17, 26.2 m @ 98 yrs.): Poor site
   correction (from Figure 5.17, 0.3 m on Poor site): 3 years
   total age: 98 + 3 = 101 yrs.
   Check: 26.2 @ 101 yrs. is still Poor site class
   Record: 101 yrs. as total age
2. tree species: Coast Douglas-fir
   counted age: 87 yrs.
   B.H.: 0.9 m
   total height: 41.5 m
   site class (from Figure 5.17, 41.5 m @ 87 yrs.): Good site
   correction (from Figure 5.17, 0.9 m on Good site): 5 yrs.
   total age: 87 + 5 = 92 yrs.
   Check: 41.5 m @ 92 yrs. is Medium site class
      Correction for Medium at 0.9 m is 7 years, therefore
      use average of Good and Medium corrections (5 + 7) ÷ 2 = 6
   Record: 87 + 6 = 93 yrs. as total age

The general rule is that when the site class changes after the correction has been added, the average of the corrections for the two site classes (pre-correction and post-correction) is used.

Height Calculations

TOP

The percent slope reading to the top of the tree; the sign must be shown (usually " + "). The maximum allowed reading is 100%. If a reading greater than 100 is obtained, move further from the tree, or upslope.

BOT. (bottom)

The percent slope reading to the base of the tree or to lowest visible point; the sign must be shown (may be + or −). The maximum allowed reading is 100%.

TOTAL

This value is the algebraic subtraction of "TOP" and "BOT." readings, for example, if "TOP" readings
+ 60%, and 'BOT.' reading is − 20%, TOTAL is 60 − (− 20) = 60 + 20 = 80%, or if
'TOP' is + 60%, and 'BOT.' + 20%, TOTAL is 60 − (+ 20) = 60 − 20 = 40%

In other words, if the signs are different, add; if the signs are the same, substract, disregarding the signs.

S.D. (slope distance)

S.D. is the slope distance in metres (to one decimal) from the observer to the center of the tree trunk at breast height.

SLOPE

Slope is the percent reading from the observer to the tree along the slope of the measuring tape.

H.D. (horizontal distance)

H.D. is the horizontal distance obtained by multiplying the slope distance by a slope distance factor. H.D. = S.D. × slope distance factor (see Table 5.4).

Table 5.4 Slope distance factors

% Slope	Factor	% Slope	Factor	% Slope*	Factor
10	.995	30	.958	50	.894
11	.994	31	.955	55	.876
12	.993	32	.952	60	.857
13	.992	33	.950	65	.838
14	.990	34	.947	70	.819
15	.989	35	.944	75	.800
16	.987	36	.941	80	.781
17	.986	37	.938	85	.762
18	.984	38	.935	90	.743
19	.982	39	.932	95	.725
20	.980	40	.928	100	.707
21	.979	41	.925	105	.690
22	.977	42	.922	110	.673
23	.974	43	.919	115	.656
24	.972	44	.915	120	.640
25	.970	45	.912	125	.625
26	.968	46	.908	130	.610
27	.965	47	.905	135	.595
28	.963	48	.902	140	.581
29	.960	49	.898	150	.555

* interpolate for slopes between these values

HT. (height)

This item is the tree height (m) to one decimal, calculated as follows:

(TOTAL × H.D.) ÷ 100

COR. (Correction)

If "BOT." reading was not taken at the base of the tree, the height at which it was taken is entered in this column. Then, "HT." + "COR." = Total Height.

An example of a height calculation follows:

TOP: +62 BOT.: −24 TOTAL: 62 − (−24) = 86
S.D.: 20.5 m slope: 23% slope distance factor: 0.974
H.D.: 20.5 × 0.974 = 20.0
HT.: (TOTAL × H.D.) ÷ 100 = 1720 ÷ 100 = 17.2 m
COR.: 1.3 m
TOTAL HEIGHT: 17.2 + 1.3 = 18.5 m

SOME TIPS TO REMEMBER

1. Cruising requires two people; it is generally inefficient for one person to attempt it alone.
2. The person tagging trees and measuring diameters should look for pathological indicators on the bottom half (approx.) of the trees; the tally person should move around and observe the top portion of the trees.
3. When measuring heights, it is generally easier and more accurate to conduct these upslope from the tree. It is easier because the top of the tree is more visible, and more accurate because the slope angle to the top (usually the highest of the two readings) is reduced, while the slope angle to the bottom (usually the lowest of the two readings) is increased somewhat.
4. To eliminate the need for slope corrections when checking borderline trees it is usually possible to hold the tape horizontally if the person upslope holds it near the ground and the person downslope holds it up. The slope of the tape can be easily checked with a clinometer (a "0" reading along the tape means it is horizontal).

For further information on cruising regulations and procedures, refer to:

1. B.C. Ministry of Forests (1984) cruise manual
2. *An Introduction to Point Sampling* by E.C. Crossin, B.C. Institute of Technology, January, 1967. (#4211 FO-305).

PATHOLOGICAL INDICATORS

The defects and pathological indicators described in this section are important because they are frequently signs of decay or rot in the wood. Only the indicators in the first section, where decay and rot are "suspect", should be used. The second section describes some abnormalities not considered "suspect" (i.e., indicative of decay). Refer to the B.C. Ministry of Forests (1984) cruise manual for more detail regarding pathological indicators.

Pathological Indicators that are Suspect (of decay or rot)

Conks — conks are the most certain and reliable indicators of decay. They appear most frequently on the underside of dead branch stubs, on branch scars, or on the underside of live branches in the crown of the tree.

Sporophores of velvet top fungus (*Polyporus schweinitzii*) are recognized as suspect indicators of decay when they appear on the soil or exposed roots immediately adjacent to the trunk of the tree.

Conks are highly variable in size and shape. They are hard to detect, particularly when they occur on the upper portions of the trunk. Conks of certain fungi, notably Indian paint fungus (*Echinodontium tinctorium*) and red ring rot (*Fomes pini*), frequently occur as small, hoof-like or shell-like forms on the underside of dead branch stubs on the middle and/or lower section of the trunk of the infected tree.

Moss-covered branch stubs and burls often resemble conks, particularly when viewed from directly below, thus it is sound practice to view the tree from the side before making a decision. It is important to remember that conks can occur at any point on the trunk of the affected tree. Therefore, look for conks on both the upper and lower portions of the trunk.

Blind Conks — blind conks of *Fomes pini* are analogous to conks as indicators of decay (the term "swollen knots" is synonymous). Blind conks appear typically as pronounced swellings around knots and are in marked contrast to the normal healing over of a normal, sound knot (Figure 5.18). The swelling results from the trees attempt to heal over an abortive conk at the point from which an old conk has dropped. The swelling is often accentuated by the growing conk, which pushes out the thick, dead, outer bark of the tree. In many instances, the affected knot is partially covered by sound wood, hence the term "blind" conk. A cut with an axe into a blind conk will reveal the bright yellow or buff-coloured content of the conk itself. Blind conks occur most often on hemlock.

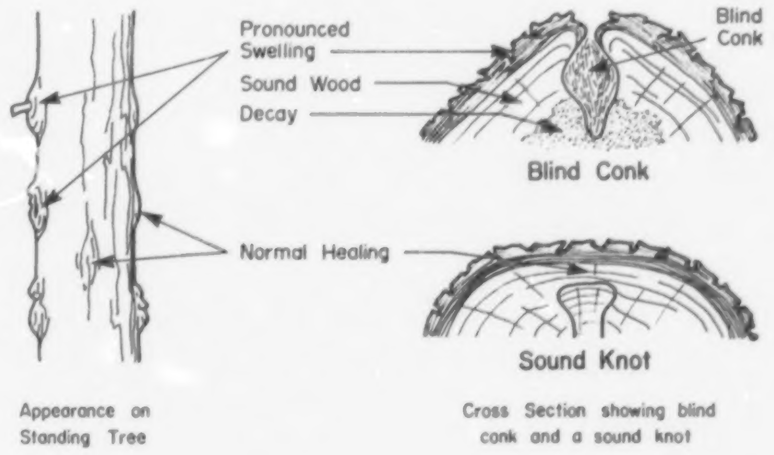

Figure 5.18 Appearance of a blind conk and sound knot on a standing tree and in cross-section

Scars — "suspect" scarring includes any injury, not recent in origin, caused by certain external physical forces or agents, which has exposed the heartwood and/or sapwood of the tree to attack by wood-rotting fungi. See "Forms of Scars" (a) and "Kinds of Scars" (b) that follow.

(a) Forms of Scars

Closed scars — closed scars appear, in the case of early scarring, as healed over, slight to pronounced indentations of the bark. Later scarring appears as pronounced scar tissue or callous growth and frequently is the site of considerable resin flow. Figure 5.19 illustrates the appearance of freshly healed over scars and those that have been healed for some time.

Open scars — open scars appear as areas of exposed wood of varying size and shape. They result from severe damage to the tree from fire, lightning, logging, machinery, etc. Scarring of this nature is slow to heal over and the wood tissues of the tree may remain exposed for a considerable time. Depending upon the extent and severity of damage to the tree, two types of open scars are recognizable. The first type results where damage is largely confined to the bark and cambium layers with little or no damage to the wood. In scars of this type the appearance and contour of the exposed wood is not appreciably altered (see Example A, Figure 5.20). The second type of open scarring results from extensive damage to the wood and is generally referred to as "catface" (see Example B, Figure 5.20).

(b) Kinds of Scars

Fire scars — fire scars appear typically as slight to pronounced indentations in the tree, in cases of early scarring which has healed over. Open catfaces or hollowing of the trunk indicates fire scars of later or more severe damage. Fire scars are usually confined to the basal portion of the trunk.

Fire scars are important indicators of decay. Trees growing in forest stands having a fire history should be carefully examined for evidence of fire scars. There is usually some evidence of burning, either as charred wood within the scar itself or charring in root crotches or on exposed roots.

Lightning scars — lightning causes extensive damage to the trunks and tops of trees. Lightning scars typically appear as narrow to fairly wide strips of torn wood, often extending down the entire length of the tree in the form of a spiral.

Falling-tree scars — trees are frequently scarred by other trees falling against them. Scars of this type are common in selectively cut stands as well as in natural stands. Evidence of this kind of scarring is often indicated by the presence of the fallen tree against or near to the scarred tree.

Logging or other machinery scars — logging equipment or other machinery may cause extensive damage to seed trees in or adjacent to the residual stand following selective cutting. Scarring of this nature is usually confined to the basal portion of the trunk, but may also occur on the upper portion of the trunk when it is caused by rigging.

Old blazing — old blazes are frequent entry points for wood-rotting fungi. Care must be taken to exclude recent blazing that is not "suspect".

Scars caused by breakage — scarring of the trunks of trees occurs when live branches, secondary leaders, or suckers are broken from the trunk by high winds, heavy snow, or branches falling from adjacent trees.

Animal or bird scars — various members of the animal kingdom cause damage which may be classed as "suspect" scarring. Woodpeckers, bears, deer, rodents, and beavers frequently cause extensive damage to the trunks of trees.

Woodpeckers frequently scar trees by making holes of considerable size and depth in their trunks. Woodpecker holes remain open for considerable time, providing entrance for wood-rotting fungi. Sapsucker holes, however, are superficial and are classed as "non-suspect" (see "Abnormalities that are not suspect").

Bears, deer, moose, and elk sometimes cause extensive damage by removing areas of bark and cambium from the trunks of trees. Scars caused by bear claws are common in many forest stands. Beavers and other rodents also cause severe damage to trees by gnawing on extensive areas of the trunk.

Extreme care must be taken, however, to exclude superficial damage caused by these agents. Scarring caused by birds or animals must comply with the basic principle defined (i.e., the heartwood and/or sapwood must be exposed) to be classed as "suspect".

Cankers caused by fungi — cankers caused by fungi result in the death of localized areas of bark and cambium on the trunks of trees. Eventually the dead bark is sloughed off, exposing the underlying wood. There is usually evidence of repeated callous growth, and for this reason cankers are frequently mistaken for "mechanical" scars. Cankers are usually flattened, elongate, and of irregular shape. The exposed wood is often stained and impregnated with resin (Figure 5.21). Fruiting bodies of the fungus may also be in evidence.

Scars caused by rock slides or falling rock — rock slides cause extensive damage to trees in their path. Scars caused by rock slides are usually confined to the basal portion of the trunk. Falling rock, on the other hand, sometimes scar trees at considerable height above ground, either because snow levels may be at considerable height above ground or rocks may bounce (Figure 5.22). In both instances, scars usually occur on the upslope side of the trees.

Scars of undetermined origin — any scar that exposes heartwood and/or sapwood is sufficient cause to record the affected tree as "suspect", providing the scar is not of recent origin. The way in which the scar may have originated is irrelevant.

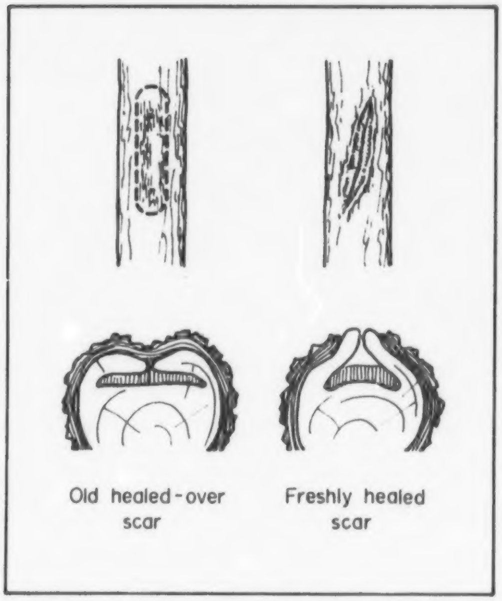
Old healed-over scar
Freshly healed scar

Figure 5.19 Appearance of scars which are old or freshly healed

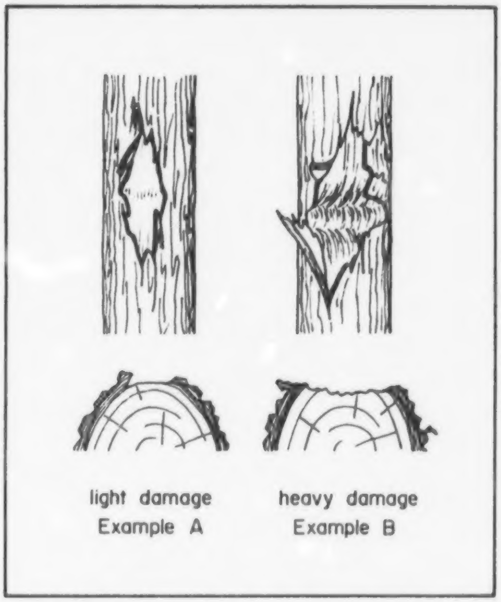
light damage Example A
heavy damage Example B

Figure 5.20 Appearance of scars with light or heavy damage

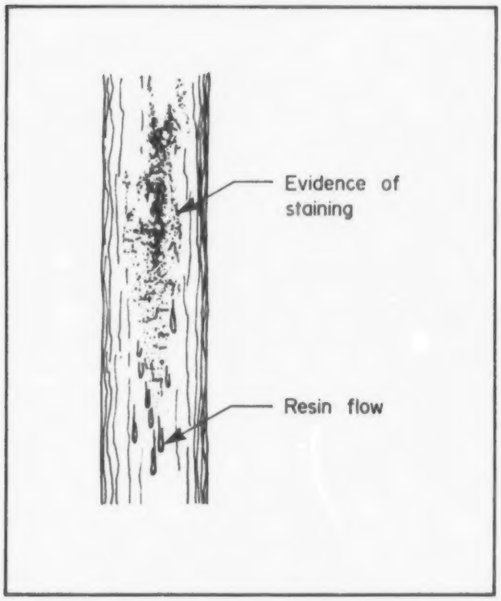
Evidence of staining
Resin flow

Figure 5.21 Appearance of cankers caused by fungi

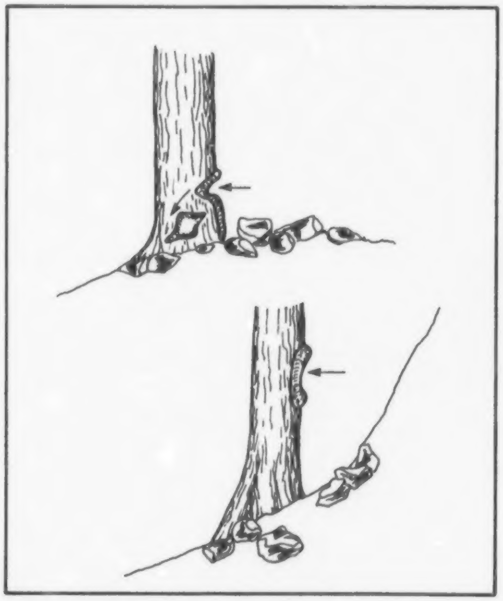

Figure 5.22 Appearance of scars caused by rock slides or falling rock

Fork or crook — a fork or pronounced crook that is confined to the portion of a tree trunk between mean ground level and the tip of the tree should be classed as "suspect". Suspect forks or crooks originate from the development of secondary leaders from the trunks of the trees.

A fork or crook that develops as the result of an early injury to the top of the tree is a reliable indication of decay. Although all evidence of the original top may have disappeared or healed over, the original injury provided an entrance point for decay fungi. In many cases, evidence of the original top exists along with some evidence of scarring. A pronounced crook can also develop from the breaking-off of one of the leaders of a forked tree.

Examples A, B, and E in Figure 5.23 illustrate forks which occur in the merchantable portion of the trunk. Examples C and D illustrate forks that occur on the basal portion of trees while examples F and G illustrate pronounced crooks. All of these examples *except E* are considered "suspect".

Forking which develops from malformation of the terminal leader as a result of insect or mistletoe attack, or which is a growth characteristic of the species (for example, yellow pine, and most deciduous species) has no decay significance and is, therefore, "not suspect".

Frost Cracks — frost cracks result from deep radial splitting of the trunk, caused by uneven shrinkage of the wood following a sudden and pronounced drop in temperature. The cracks usually originate at the base of the trunk and may extend many metres up the tree. Frost cracks are often re-opened repeatedly by wind stresses or low temperatures. Repeated healing of the wood produces considerable callous tissue, giving the wound a pronounced ribbed appearance (Figure 5.24). Trees with frost cracks should be recorded as "suspect".

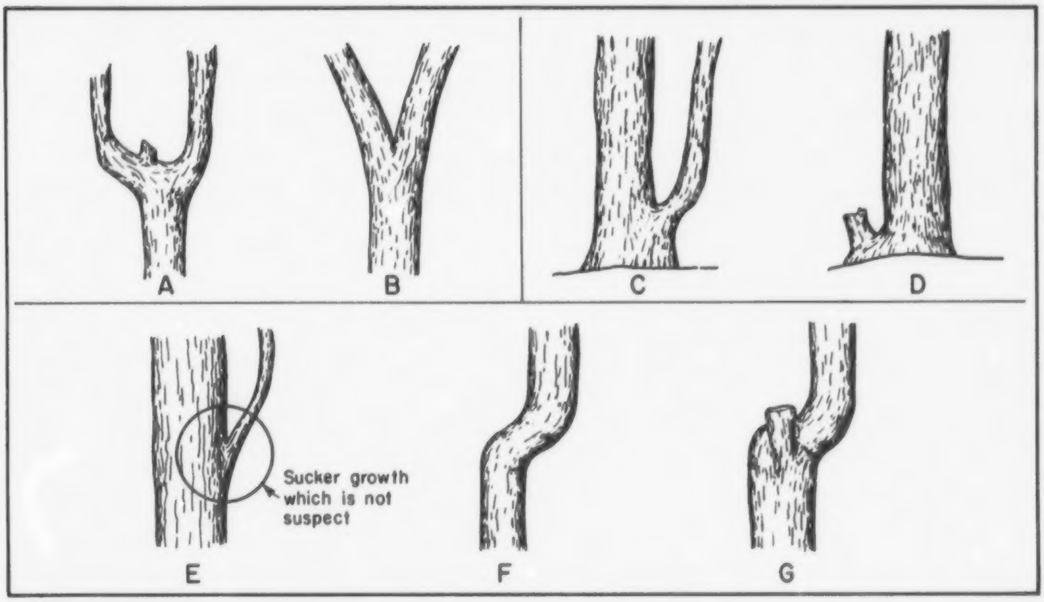

Figure 5.23 Appearance of different forms of forks and crooks

Mistletoe — infection by mistletoe is indicated either by abnormal swelling or malformation of the trunk at the point of infection (Example A, Figure 5.25), or by clusters of dead and broken branches on the trunk or on hypertrophied (i.e., swollen) branches immediately adjacent the trunk (Example B, Figure 5.25).

Wood-rotting fungi gain entrance to the trunk through the dead, hypertrophied branches or branch stubs when the swelling is on, or adjacent to the trunk. Mistletoe infections are "not suspect" when they occur on limbs that are swollen at a distance greater than 30 cm from the trunk. Include only those branch infections in which the swelling has clearly extended to within 30 cm of the trunk (Figure 5.26).

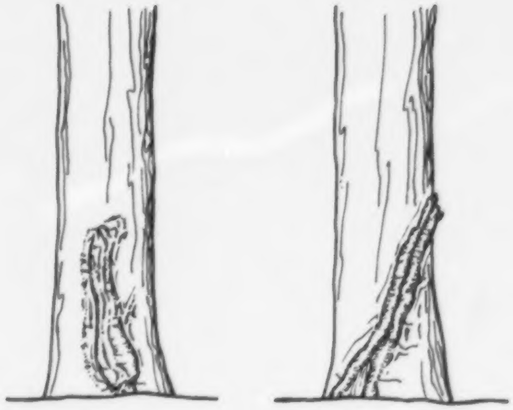

Figure 5.24 Appearance of frost crack on standing tree and in cross-section

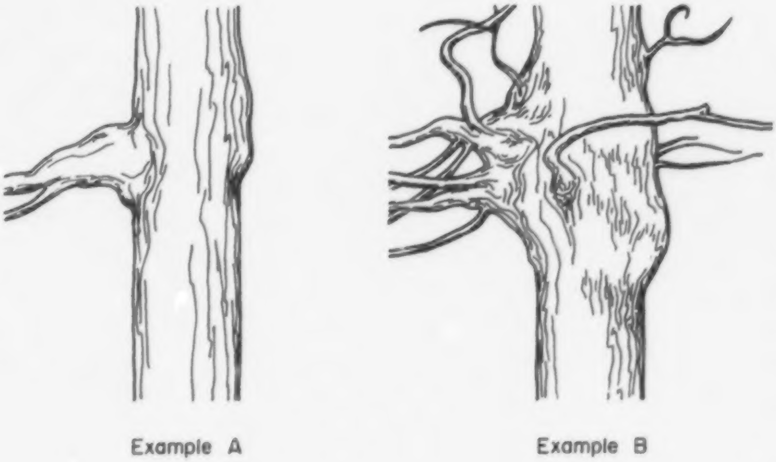

Figure 5.25 Example of mistletoe infection

Rotten Branch — large, rotten branches, which appear typically on old-growth trees, are often indicative of decay in the standing tree. Large branches that are broken off close to the trunk expose a large amount of heartwood to entry by wood-rotting fungi. Such branches usually appear singly at various points on the trunk, or in groups at some distance below the live crown of the tree.

Include only large branches (i.e., 10-15 cm or larger in diameter) that are clearly rotten. Do not include small, dead branches that typically appear just below the live crown or on the lower trunk of open grown trees (Figure 5.27).

Dead or Broken Top — under this heading include only dead or broken tops not recent in origin. Broken tops must be obviously weathered to be included.

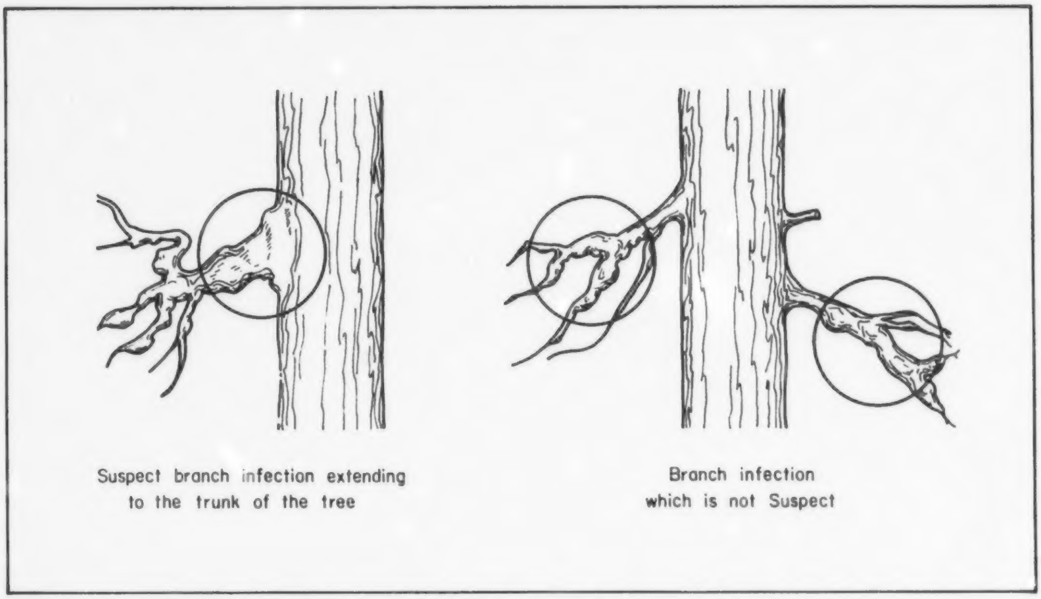
Suspect branch infection extending to the trunk of the tree
Branch infection which is not Suspect

Figure 5.26 How to determine if mistletoe infection causes tree to be suspect

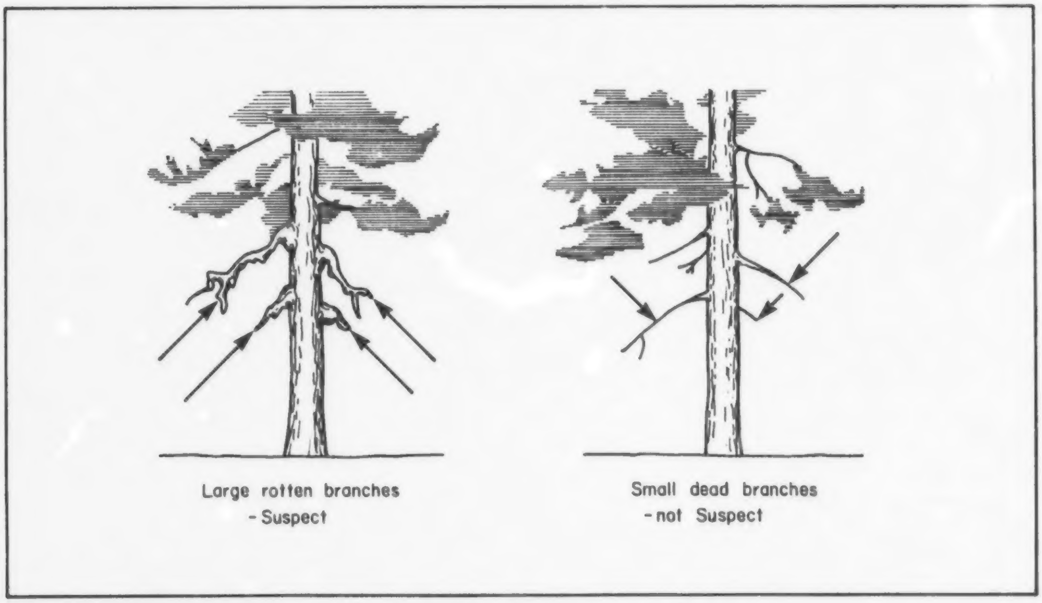
Large rotten branches - Suspect
Small dead branches - not Suspect

Figure 5.27 Rotten branches cause tree to be suspect

Abnormalities that are Not Suspect

External Evidence of Butt Rot not Associated with "Suspect" Abnormalities — butt rot may be evident in exposed roots or within root crotches. Unless one or more of the previously described "suspect" abnormalities appears on the tree, however, such trees should *not* be classed as "suspect".

Flutes — pronounced flutes on the trunk are a common growth characteristic of many species. They have no decay significance (Figure 5.28).

Candelabra Branches — "candelabra" branches develop as a result of abnormal branch growth and are often confused with "suspect" forking. Branching of this type has no decay significance. It is important to note that candelabra branches do not originate as a fork in the trunk of a tree (Figure 5.29).

Branch Fans — branch fans develop through abnormal branching and are "not suspect". They appear most commonly as "fans" of branches originating from burl-like swellings on the trunks (Figure 5.30).

Black Knots — black knots frequently develop around unhealed knots and wounds. The blackened appearance develops from a superficial saprophytic fungus which feeds on the exuded sap (Figure 5.31). Black knots are quite sound when cut into with an axe, and they have no decay significance.

Burls and Galls — burls and galls develop from abnormal cell growth in trees and, although formidable in appearance, have no decay significance (Figure 5.32).

Sweep — sweep, which develops as a slight curvature or distortion of the trunk, has no decay significance and is "not suspect" (Figure 5.33).

Exposed Roots — exposed roots and buttress roots have no established decay significance unless scarring is present above mean ground level (Figure 5.34).

Spiral Grain — spiral grain is a growth characteristic of some trees and has no decay significance.

Dry Side — dry side results from the death of the cambium as a result of bruising by other trees or from other physical causes. Dry side appears as a narrow to wide strip down the side of the tree, or in small, localized areas. The bark often remains intact over the dead areas. Although dry side may result in the rejection or degrade of a pole tree, it has no established decay significance.

Sapsucker Holes — sapsucker holes are superficial and have no established decay significance, in marked contrast to the "suspect" scarring caused by woodpeckers (Figure 5.35).

Insect Borings — borings by bark beetles or other insects have no established decay significance and should not be classed as "suspect".

Non-suspect Forking — Figure 5.36 shows two types of "non-suspect" forking common in deciduous trees. Deciduous trees with U-shaped forks containing a dead branch are definitely "suspect". "Non-suspect" forking is more V-shaped. Trees growing in clumps, such as birch, should not be classed as suspect on the basis of this characteristic alone.

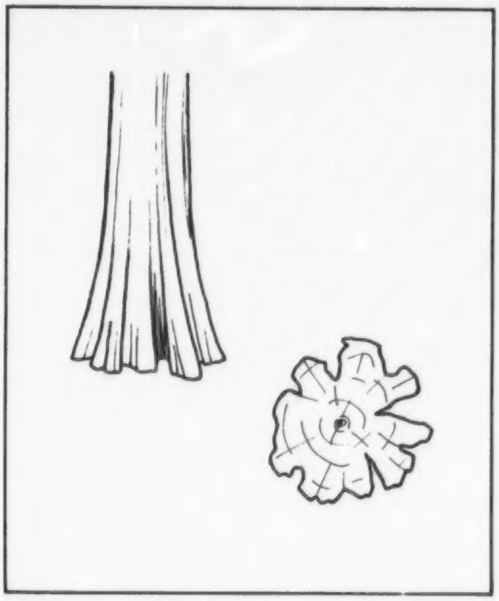

Figure 5.28 Examples of pronounced flutes

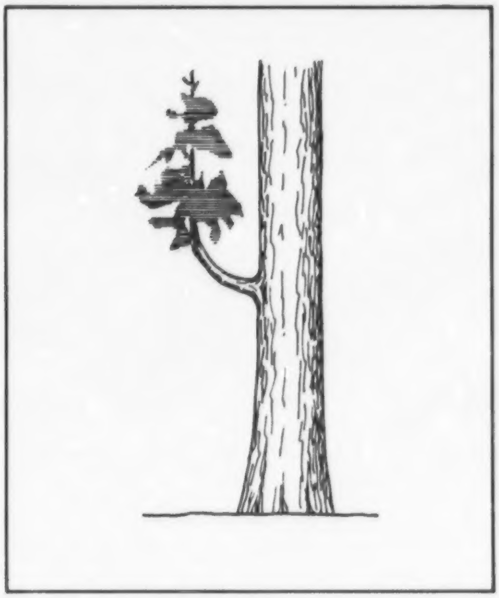

Figure 5.29 Examples of candelabra branches

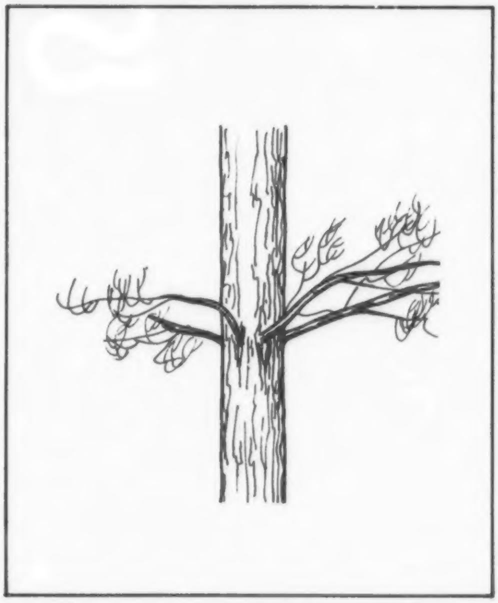

Figure 5.30 Example of branch fans

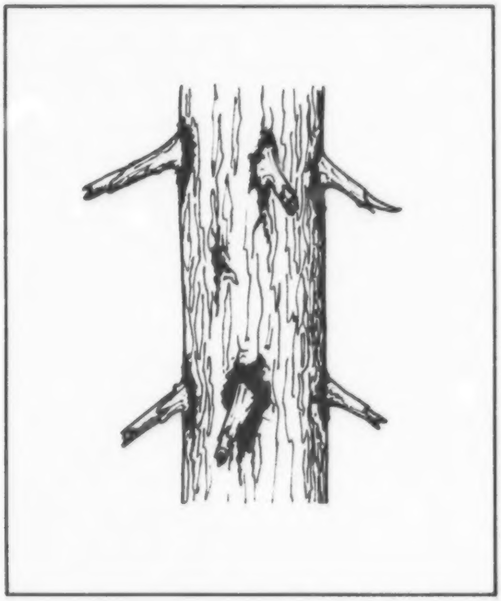

Figure 5.31 Example of black knots

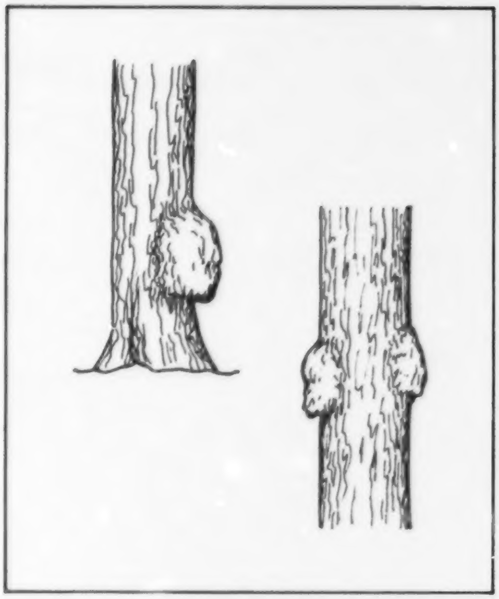

Figure 5.32 Example of burls and galls

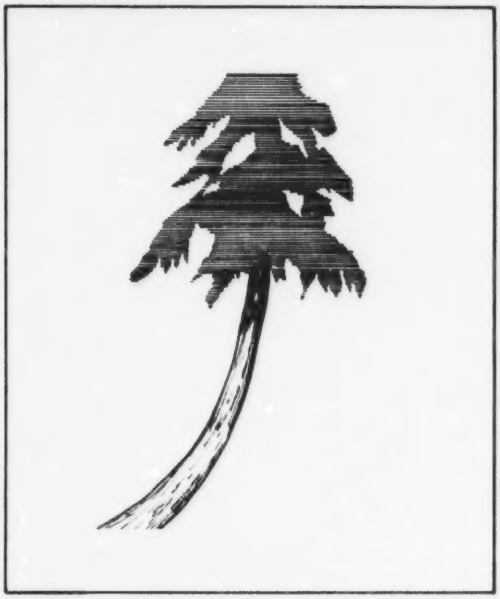

Figure 5.33 Example of sweep

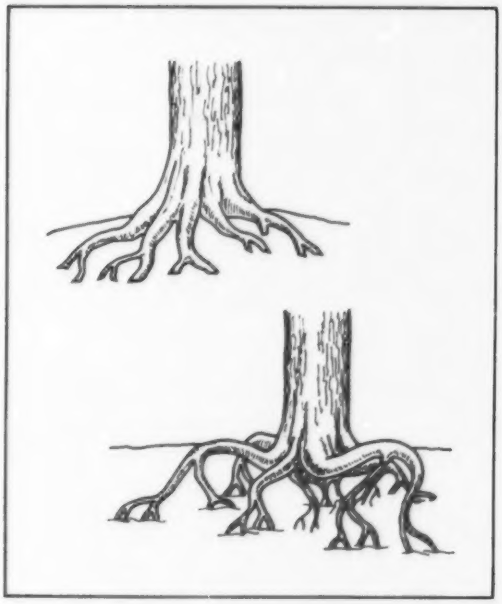

Figure 5.34 Example of exposed roots

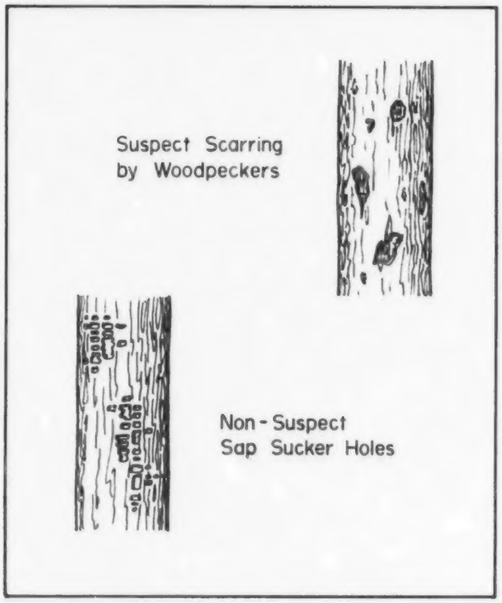
Suspect Scarring
by Woodpeckers
Non - Suspect
Sap Sucker Holes

Figure 5.35 Appearance of suspect scarring by woodpeckers, and non-suspect sapsucker holes

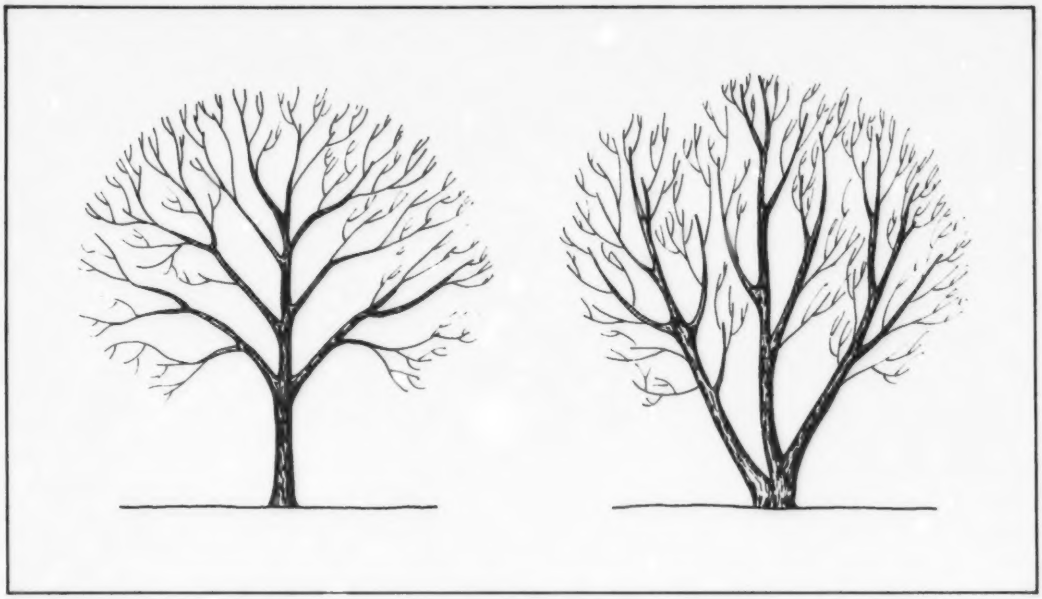

Figure 5.36 Examples of natural forking that are not classed as suspect

CHAPTER 6

WILDLIFE DESCRIPTION

WILDLIFE DATA FORM

ADDW00
if continuation then
put X over ADDW00

SERIES☐☐ FORM☐☐☐☐☐ SUBPLOT☐ PROJECT ID.____________ PLOT NO.______ SURVEYOR____________ PAGE ____ OF ____

DATE ____________

PHOTO ____________

	16 17 18 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56 57 58	59 60 61	62	63	64 65	66	67 68	69 70	71 72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
	COUNT								ACTIVITIES																SIGN													HABITAT										HABITAT FACTORS													
	SPECIES			NUMBER																					GENERAL							PELLET COUNTS						HABITAT TYPE		W/L				FORAGE SPECIES				Human Activity								Enhance -ment					
																																Winter		Summer																											
COMMON NAME	CODE	Sex	Age	N	N	N	N	Code	Feeding	Courtship	Rear./ Inc.	Sleep/Bec	Loafing	Preening	Bathing	Ins. Avoid.	Alert	Commute	Migrate	Fly	Run/Walk	Swim	Unclassified	Comment	N	N	Code	N	N	Code	Comment	N	N	N	N	Method	Comment	Code	Code	Distance	Code	Season of Use	Habitat Use	Code	Code	Code	Comment	Distance	Type	Snow	Landform	Pres.Adj.Esc./Cov.	Pres. Prod.	Pot. Prod.	Maintenance	Obj.	Potential	Technique	Pres. Suit.	Capability	Comments
ADDW01																																																													

Province of British Columbia
Ministry of Environment and Parks

COMMENTS

ADDW02	1	
	2	
	3	
	4	

DK 738 ENV 1960

Chapter Six

WILDLIFE DESCRIPTION

INTRODUCTION

The Wildlife Data Form is for recording site specific information on wildlife habitat and populations. The entire form need not be filled out by all investigators. Instead, specific portions of the form should be used according to the objectives of the study and expertise of the field investigator. The form was originally developed to accommodate data relating to several programs, including:

- — coastal waterbird census conducted by the Wildlife Branch and Canadian Wildlife Service;
- — land capability for wildlife classification, an ecological (biophysical) approach for ungulates; and
- — ecological or biophysical surveys in which wildlife data are collected to complement soil and vegetation data.

Considerable information relevant to site specific wildlife use (e.g., browsing assessment and grazing level ratings) are incorporated in the Vegetation Description Form (Chapter Four).

SITE DESCRIPTION FORM — WILDLIFE INPUT

A Site Description Form (Chapter Two) must be coded to accompany each Wildlife Data Form. Site data items 1, 2, 3, 4, 5 or 6, 7, 8, 9, 10, 11, 18, 50, and 51 must be filled out in every case, and where applicable, data items 19, 20, 21, 22, 25, 26, 27, 34, and 39 should be completed as well.

Because the Site Description Form was originally designed for soils/vegetation surveys, it does not accommodate some of the general information normally recorded by wildlife biologists conducting field surveys. For example, space has not been provided for recording factors such as time, weather, and other environmental conditions which may influence animal distribution and abundance.

To record this information in a computer compatible format, a portion of the "Plot Representing" section (Item 18) of the Site Description Form has been structured to accommodate general information pertaining to wildlife surveys. Codes and data recording instructions follow. Parameters that are not applicable at the time of the survey should be left blank.

Survey Type

Survey Type records the primary objective of the survey and the surveyors mode of transportation while observing wildlife. Enter "R" in space 79, followed by the appropriate objective code in space 80, transportation code in space 81, and a semicolon in space 82.

	Code	*Description*
Objective:	C	Classified count (i.e., numbers by sex and age)
	H	Habitat (animal distribution by habitat)
	I	Incidental (animals are noted only as an incidental part of a survey)
	O	Other
Transportation:	A	Wildlife observed from automobile
	B	Wildlife observed from boat
	F	Wildlife observed from fixed-wing aircraft
	G	Wildlife observed from the ground
	H	Wildlife observed from helicopter

Time Started

Enter "TS" in spaces 83-84, followed by the time of day that the observation period began in spaces 85-88 (use 24 hour clock, e.g., "1400" is 2:00 P.M.), and a semicolon in space 89.

Time Finished

Enter "TF" in spaces 90-91, followed by the time of day (use 24 hour clock) that the observation period finished in spaces 92-95 and a semicolon in space 96.

Temperature

Enter "TE" in spaces 97-98, followed by the air temperature (°C) at the time of the survey in spaces 99-101, right justified (minus temperatures should be preceded by a minus sign), and a semicolon in space 102. Temperature is recorded to the nearest °C (no decimals are allowed).

Overcast

Enter "OV" in spaces 103-104, followed by percent overcast (an entry of 99 will be interpreted as 100%) in spaces 105-106, and a semicolon in space 107.

Precipitation

Enter "PR" in spaces 108-109, followed by the appropriate precipitation type code in space 110, the intensity code in space 111, and a semicolon in space 112.

	Code			*Code*	
Type:	R	rain	Intensity:	L	light
	S	snow		M	moderate
	X	sleet		H	heavy
	H	hail		I	intermittent
	N	nil			

Snow Amount

This item identifies the amount of snow on the ground at the time of the survey. Enter SNOW-A in spaces 120-125 (spaces 113-119 are left blank for possible project specific uses), followed by the appropriate numeric code from the following list in space 126, and a semicolon in space 127.

Code		*Code*	
0	nil	4	50-75 cm
1	partial or intermittent	5	75-100 cm
2	1-25 cm	6	100-125 cm
3	25-50 cm	7	>125 cm

Snow Conditions

Enter "C" in space 128, the appropriate numeric code from the following list in space 129, and a semicolon in space 130.

Code	
1	soft, fluffy, and dry
2	soft and wet
3	soft, wet, and dense
4	subsurface crust
5	surface crust

Time Since Last Snow

Enter "T" in space 131, the appropriate numeric code from the following list in space 132, and a semicolon in space 133.

Code	
1	fresh snow; within last 12 hours
2	recent snow; within last 48 hours
3	old snow; within past 2 weeks
4	stagnant snow; no new snow within past 2 weeks

Plant Growth Stage

Enter "PG" in spaces 134-135, the appropriate numeric code from the following list in space 136, and a semicolon in space 137.

Code	
1	winter dormancy; no deciduous plant growth
2	spring green-up; deciduous plant growth beginning
3	summer growth; plant growth active and complete
4	autumn senility; plant growth declining, leaves falling

Tide

Enter "TD" in spaces 140-141 (spaces 138-139 are left blank), followed by the appropriate tide stage code in space 142. Tide height in metres at the time of observation in is recorded spaces 143-145, and semicolon is placed in space 146. Tide height should be recorded to the nearest decimetre (the decimal is placed in space 144).

	Code	
Tide stage:	+	flooding
	—	falling
	0	slack

Water Surface Conditions

Enter "SS" in spaces 147-148, the appropriate code from the following list in space 149, and a semicolon in space 150.

Code		*Code*	
S	smooth	W	swell
R	rippled	G	sunglare
C	choppy		

Wind Direction

Enter "WD" in spaces 151-152, the appropriate wind direction (i.e., N, E, S, W, NE, NW, SE, or SW), left justified in spaces 153-154, and a semicolon in space 155.

Wind Speed

Enter "S" in space 156, followed by wind speed in kilometres at the time of the survey, right justified in spaces 157-158, and a semicolon in space 159.

Visibility

Visibility as it affects the surveyor's ability to observe and count wildlife is recorded by noting its quality and condition. Enter "V" in space 160, followed by the appropriate quality code in space 161, condition code in space 162, and a semicolon in space 163.

	Code			*Code*	
Quality:	G	good	Condition:	D	dawn or dusk
	M	moderate		F	fog
	P	poor		P	precipitation (rain or snow)
				S	sunglare
				O	other

WILDLIFE FORM — INTRODUCTION

Series and Form Number

Series and form numbers must be identical to those on the corresponding Site Description Form. Space is provided for subplot letters (i.e., A, B, C, etc.) when two or more subplots are described for a particular site location.

Project ID

The project identification code must be identical for all forms in a given project.

Plot No.

The way in which the plot number is entered is at the discretion of the project co-ordinator. In some projects it may be useful to assign the first character the value 1, 2, or 3 to identify whether the data form represents a rapid, intermediate or detailed examination.

Surveyor

Enter the last name of the individual completing the form. Where more than one individual is involved, dashes should be used between the names.

Page

Space is provided at the upper right of the data form to enter the total number of ecosystem description forms used for the described site, and to paginate the wildlife form(s) used in that context. For example, if one site description, one soil description, two vegetation description, and two wildlife data forms are used, the first Wildlife Data Form is identified as page 5 of 6.

Date

Enter the date on which the Wildlife Data Form is completed in the field.

Photo

Enter the roll and photograph number(s) of any wildlife or habitat photos or slides taken of the site.

COMMON NAME

The common names of all species observed can be entered in "columns" 1-14. Although this information is not entered into the computer data bank, it can be recorded for field use. The last "column" of this field (15) should be used for the vertebrate group code: amphibians (A), reptiles (R), birds (B), or mammals (M). This will be added to the species codes (columns 16-19) to form a five letter code for all species of vertebrates.

COUNT (columns 16-26)

Species Code (columns 16-19)

Five letter codes developed by Cannings and Harcombe (1990) for wildlife species in British Columbia are presented in Table 6.5 at the back of this Chapter. The codes are derived from a single letter code for the vertebrate group (see Common Name) added to a four letter code derived from the scientific names of amphibians, reptiles, and mammals, and from the accepted common names of birds. The table also includes codes for ungulate subspecies and common domestic species. The rules that were followed in developing the codes are:

Amphibians (A), reptiles (R) and mammals (M): codes are the first two letters of the genus and first two letters of the species scientific name (e.g., *Alces alces* = ALAL for moose).

Birds (B):
(a) if the common name is a single word, the code is the first four letters (e.g., Bufflehead = BUFF);
(b) if the common name is two words, the code is the first two letters of the first word, combined with the first two letters of the second word (e.g., Common Loon = COLO);
(c) if the common name is three words (with or without hypens), the code is the first letter of the first two words, combined with the first two letters of the third word (e.g., Pied-billed Grebe = PBGR; Great Gray Owl = GGOW); and
(d) if the common name is four words (with or without hyphens), the code is the first letter of each word (e.g., Black-crowned Night-Heron = BCNH; Black-and-White Warbler = BAWW).

Unspecified: If the individual species is not determined but is narrowed-down to a group of species then the first letter of the code begins with the letter "U" (for unspecified) and the remaining 3 letters are derived from the common name of the species group (e.g., unspecified snake = USNA; unspecified bear = UBEA; unspecified storm petrel = USTP).

Because of occasional duplications in the species code, a few codes do not follow the conventions described. Always refer to Table 6.5 to confirm that the code used is correct.

Sex (column 20)

Codes for sex are:

F — Female
M — Male
U — unknown; sex is either unknown or unimportant to record

Age (column 21)

Codes for age are:

J — Juvenile — an individual apparently too young to breed (usually less than three seasons old) and still distinguishable from breeding adults by external characteristics
S — Subadult — an individual that has not bred, but resembles an adult
A — Adult — an individual that is mature enough to breed
U — Unknown

Count Number (columns 22-25)

The total number of individuals of a species up to 9999 are recorded, right justified, in the four spaces provided. If a species at a given location is comprised of individuals of different sex and/or is using different habitat types, the investigator can record this on separate lines of the data form.

Count Code (column 26)

Codes to indicate the type of census are:

C — complete count.
I — incomplete count (not all individuals at the site are included within census); includes a transect or count of only specific species or groups of species. Explain in comments section.
E — estimate; species are either partly obscured or seen for too short a time for an accurate count.
N — casual observation; not a routine census.
S — sound; species are identified by sound rather than visually; includes vocalizations, drummings, tappings, and scratchings.

ACTIVITIES (columns 27-42)

Description of different animal activities follow. Record the percent of animals taking part in each activity according to the following codes. Total activities must add to 100%, whereas the codes do not have to add to six. For example: a code 6 alone means only one activity; two code 3's means equal time between two activities; a code 3 and a code 4 means that one activity is being conducted slightly less than the other; a code 1, 2 and 5 means one activity is rare, another is infrequent and the third is most prevalent.

Code	
0	0%
1	0 — 5%
2	6 — 25%
3	26 — 50%
4	51 — 75%
5	76 — 95%
6	96 — 100%

Feeding (column 27)

Includes behaviour directed toward obtaining and consuming food items.

Courtship (column 28)

Copulation and behaviour oriented toward enticing another individual into copulation. Examples of such behaviour include territorial displays and sounds, courtship feeding, and aggressive behaviour exhibited by conspecifics during the mating season.

Rearing/Incubation (column 29)

Behaviour oriented toward caring for young or eggs, including bearing of young.

Sleeping/Bedding (column 30)

Animal has taken the sleeping position, or has retired to a location normally used for sleeping, such as a lair, den, bed, or roost.

Loafing (column 31)

Behaviour that appears to be lazy or idle in nature, including sunning and standing.

Preening (column 32)

Behaviours oriented toward grooming, trimming, or dressing of fur or feathers with the tongue or beak, including rubbing of velvet and scratching.

Bathing (column 33)

Behaviours involving immersion of the body in water but not for swimming or feeding; also includes dirt and mud baths.

Insect Avoidance (column 34)

Behaviour oriented toward avoidance of insects, such as caribou standing on snow fields in summer when insects are abundant.

Alert (column 35)

Behaviour directed toward detection of predators, e.g., guard or sentry duty.

Commuting (column 36)

Regular daily trips, e.g., daily flights to and from a roosting site.

Migration (column 37)

Regular (annual) trips, e.g., bird, whale, or sea lion migration.

Descriptions of several activities that apply to non-commuting or non-migratory oriented movements follow:

Flying (column 38)

Includes flying, gliding, hovering, soaring, etc.

Running/Walking (column 39)

Includes walking, running, cantering, hopping, galloping, etc. Also includes slithering.

Swimming (column 40)

Includes all forms of locomotion in, or through a body of water.

Unclassified (column 41)

This category is used when behavioural information cannot be recorded because time does not permit, or when behaviour is too ambiguous or diversified to categorize.

Comment (column 42)

If the activity (or activities) observed is suspected to be in response to the observers presence, place an "X" in this column for the affected wildlife species. If not used for this purpose, the column can be used to further describe an activity, by entering here a numeric code (1 to 4) from the smaller "COMMENTS" near the bottom of the Wildlife Data Form (transaction identifier ADDW02). Enter the appropriate numeric code (e.g., 1) in the upper box and describe the activity in free format in the lower box. Another unique activity comment code (e.g., 2) can be entered in shaded boxes under columns 16 for further comments as space allows.

SIGN (columns 43-55)

General (columns 43-49)

Sign represents indirect evidence of an animal's presence or use of the habitat. The number of items (e.g., antlers) comprising the sign should be entered right justified in columns 43-44 and 46-47, followed by the appropriate sign code in columns 45 and 48. Space is provided to enter up to two kinds of sign: columns 43-45 record those that are more important; columns 46-48 are used for those that are less important. Alternatively, instead of specifying actual numbers, the codes H, M, L, or T for high, moderate, low, or trace, respectively, can be entered in columns 43 and 46 to denote relative abundance. Comments can be noted in column 49 according to the procedures outlined previously for Comment (column 42).

Code	
A	Artifacts — artifacts include incidental portions of animal's bodies which are left behind, such as feathers, hair, and shed skins, indicating the animal is still alive. Shed antlers (C) are included in a separate category.
B	Bodies — carcasses or portions of carcasses, that indicate the animal is dead.
C	Cast Antlers — a solid, annually deciduous horn of a *Cervidae* (member of the deer family).
E	Excrement — includes feces (droppings, scats and pellet groups) — bodily wastes discharged through the anus; castings (regurgitated pellets) — bodily wastes discharged through the mouth, primarily by birds and snakes; and urine — bodily wastes secreted by the kidneys (either clear or amber fluids by mammals, or semisolids by birds and reptiles).
F	Feeding sign — includes indirect evidence such as cratering in snow or cavities in trees; and direct evidence such as chew marks on plants, sapholes in trees, and animal carcasses.
G	General Sign — non-territorial markings including dustbowls and antler rubbings on trees.
H	Homesites — homesites include nests, beds, dens, or lodges.
M	Territorial Marking — markings used by animals to indicate home range or breeding territory. Examples include elk wallows, beaver scent piles, and bear scratches on trees.
P	Path — trails embedded in the ground from animals walking over the same area for many years.
S	Sound — animals identified by sound, but not directly observed. Examples include territorial and non-territorial vocalizations; or sounds such as singing, drumming, winnowing, growling, howling and foot falls.
T	Tracks — footprints (either singular or many), or body markings on the ground.

Comment (column 49)

To be completed as discussed previously under Comments (column 42).

Pellet Counts (columns 50-55)

Pellet groups indicate the presence of ungulate species and provide a measure of abundance that is complementary to browse utilization data. There are a number of methods for establishing pellet group plots. Since the method used depends on conditions of the sample area, local biologists should be contacted for assistance in selecting the most appropriate method.

The local wildlife and/or habitat biologist should also be consulted for information regarding what ungulate species are present in the area, and where they range in winter and summer. A good reference for field identification of pellets is Murie (1975). Pellets that cannot be identified with confidence in the field should be collected for later identification. Locations of these samples must be recorded.

Averages of pellet group counts are entered under winter and/or summer as appropriate. The appropriate numeric code for "Method", as determined from the following descriptions is entered in Column 54. Counts on which averages are based may be entered as comments if so desired. "Comments" in column 55 can be numerically coded and described, following procedures previously outlined for Comments (column 42).

Method 1 is suggested for areas where shrub cover does not impede the accuracy of pellet group counts. In the centre of the survey plot, choose a tree or other object as a centre for a circular pellet group subplot of radius 4.7 m; the area of this subplot is 0.007 ha. Four additional subplots, in each of the cardinal directions (N, S, E, and W), should be established whose centres are 20 m from the centre of the first subplot. If on moderate to steep slopes, the plots can be located 20 m upslope and downslope, and to each side of the centre subplot. See Figure 6.1 for illustration of the subplot layouts.

Be sure that subplots outside of the vegetation study plot area occur within the same kind of habitat. It is essential that the subplots reflect habitat conditions described on the Site, Soil, and Vegetation Description Forms.

Method 2 is suggested for areas where shrub or other cover is so abundant that accurate pellet counts using Method 1 are physically impeded. If the plot corners are flagged and the plot measures about 20 x 20 m, pick diagonal corners as centres for the start of two sets of five pellet group subplots (Figure 6.2). If the plot is smaller than 20 x 20 m or is unflagged, pick two points approximately 30 m apart within the sample site, as the start of the subplots. Use one diagonal corner flag or marked point as the centre for a circular pellet group subplot of radius 2 m; the subplot area is 0.001256 ha.

The centre of each additional subplot is approximately 10 m from the centre of the first subplot in each of the four cardinal (N, S, E, and W) directions; or, if on moderate to steep slopes, the subplots can be located upslope, downslope, and to each side of the centre subplot. A second cluster of five subplots is established in the same fashion at the second marked subplot. Ensure that all subplots remain within the habitat type being sampled.

Method 3 is suggested for areas where shrub cover is so abundant that accurate pellet group counts using Method 2 are physically impeded. If the plot corners are flagged, pick the four corners as centres for the start of four sets of five pellet group subplots (Figure 6.3). If the plot is unflagged, pick two points approximately 30 m apart, as the centre of the subplots. Each subplot radius is 1 m; the area of each subplot is 3.14 m^2 or 0.000314 ha.

The centre of each additional subplot should be approximately 5 m from the centre of the 'starter' subplot in each of the four cardinal (N, S, E, and W) directions; or, if on moderate to steep slopes, the subplots can be located upslope, downslope, and to each side of the centre subplot. The three additional clusters of five subplots should be established in the same fashion. Ensure that all subplots remain within the habitat type being sampled.

Method 4 is a line transect method and is simpler than those discussed previously. A 1 m wide belt 50 m long is established and divided into five equal (10 m) segments. Pellet counts are conducted within each segment and the average calculated. This value equals the number of pellet groups per 0.0001 ha.

Method 5 is a visual estimate based on observer experience. Instead of specifying actual numbers of pellet groups counted, the codes H, M, L, T or N for high, moderate, low, trace or nil respectively, are entered in columns 50 and 52 to denote relative abundance of pellet groups by species.

Pellets, like other organic matter, decay and are eventually incorporated into the soil. The rate of breakdown varies greatly with exposure to weather and other factors, such as type of food from which the pellets are derived. For these reasons, the following discussion should be considered only as an approximate guide to aging. More appropriate local guidelines can usually be prepared after consultation with local biologists.

Winter Pellet Groups: pellets defecated during the past winter and, after snow melt, usually have shiny, smooth surfaces. They break open easily to reveal interiors of rich colour and usually lie on top of the forest floor (litter). Older pellets defecated prior to the past winter usually have slightly cracked and duller surfaces. The past winter's snow has aften melted through such pellets, cracking their surfaces and pressing them into little depressions in the forest floor (litter). In deciduous stands they may be fully or partly covered by leaf litter Their interior may have duller colours than those of new pellets.

Summer Pellet Groups: pellet groups defecated during the current spring or summer are usually rich in colour, have smooth surfaces, and are irregularly shaped or compacted because of the lushness of the forage consumed. These pellets have been deposited on top of the forest floor.

It is often difficult to "age" pellets because of overlap in characteristics as a result of available diet or to unusually rapid or slow rates of decay. In these cases, it may not be desirable to attempt to "age" the pellet groups,

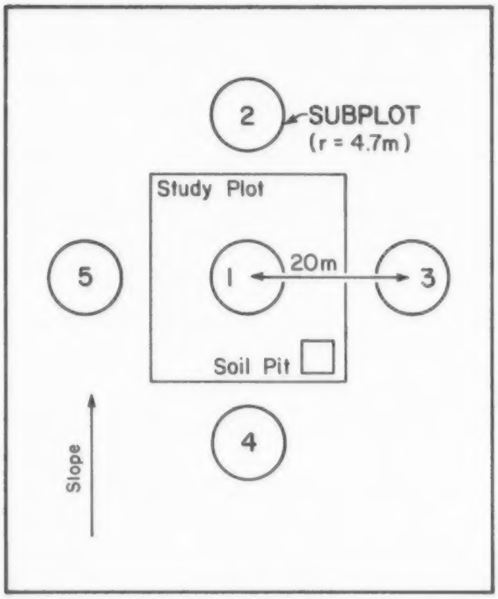
2
SUBPLOT
(r = 4.7m)
Study Plot
5
1
20m
3
Soil Pit
4
Slope

Figure 6.1 Subplot layout for ungulate pellet group counts; method 1

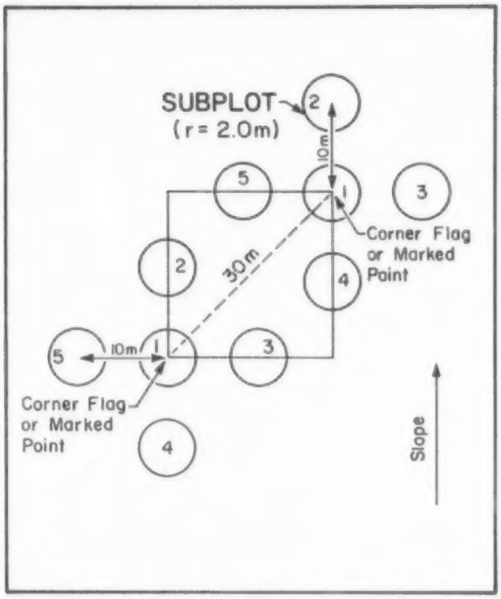
SUBPLOT
(r = 2.0m)
2
10m
5
1
3
Corner Flag or Marked Point
2
30m
4
5
10m
1
3
Corner Flag or Marked Point
4
Slope

Figure 6.2 Subplot layout for ungulate pellet group counts; method 2

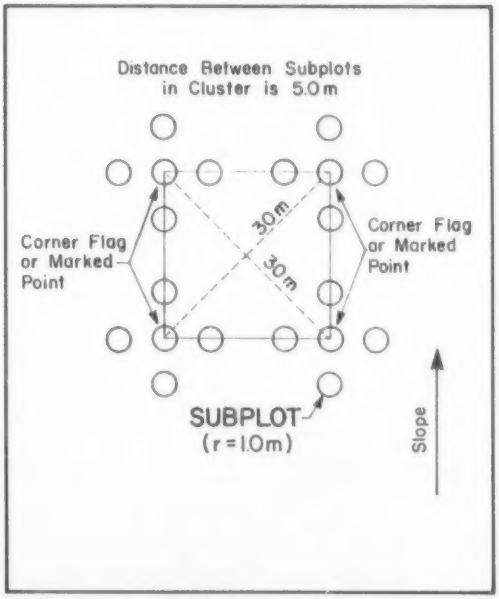
Distance Between Subplots in Cluster is 5.0m
30m
30m
Corner Flag or Marked Point
Corner Flag or Marked Point
SUBPLOT
(r = 1.0m)
Slope

Figure 6.3 Subplot layout for ungulate pellet group counts; method 3

and the following guidelines should be used instead. If the site is a known winter range, then the pellet group tally should be entered in the winter column; similarily, if the area is a known summer range, or is known not to be a winter range, then the pellet group tally should be entered in the summer column. If there is no evidence to indicate either winter or summer range, the local biologist should be consulted to help determine the area's use.

Comment (column 55)

To be completed as discussed previously under Comments (column 42).

HABITAT (columns 56-73)

Habitat Type (columns 56-61)

Habitat types are used here to place the animals that are observed, or their sign, within a habitat element of a site or within a particular coastal (subtidal/ intertidal) habitat. Two codes can be recorded, if necessary, to better describe the habitat, and the habitat element codes can be combined with coastal codes. For example, recording SNG and WAT would identify a snag in water; and FNC and IMA would indicate a fence in an intertidal marsh. The habitat element and coastal codes follow:

Code	*Habitat Elements*
AIR	flying in the air; this is general category for LOW and SKY
AVA	avalanche track
BGD	below the ground surface
BLF	on a sheer rock outcrop (bluff), either on the face or a ledge
BNK	in a cavity in a bank or cliff which is composed of unconsolidated material (ie. silt or sand)
BUS	in, or on, a bush or shrub
CAN	in the canopy of a tree
CAV	in a cave
CON	in a conifer tree
DCD	in a deciduous tree
FNC	on a fence (this is a general category)
GRD	on the ground surface
HID	hidden by cover, such as trees or bushes
HOL	in a cavity in a snag or tree
ICE	on permanent snow or ice
LCK	at, or near, a mineral lick or seep
LOG	in, or under, a log
LOW	flying low, near the ground
NST	in a nest or den
PIL	on a piling or dolphin, which is usually surrounded by water
POL	on a long pole, such as a light standard or telegraph pole
PST	on a short post, such as a fence-post
RNR	on roads or railroads that dissect the unit
ROC	in, on, or under a rock
SKY	flying high in the sky
SNG	on a snag
TAL	on, or in, talus or scree
TMK	at, or near, a territorial marking of its own making, such as a wallow, scent-post or rubbing
TRE	in a tree (this a a general category)
TRK	on the bole or trunk of a tree
UND	underwater
WAT	on the surface of the water

WDB	in, on, or under, a pile of slash, woody debris or downed tree(s)
WFL	on a floating log
WHL	at, or near a waterhole, spring or seep
WLB	on a boom of floating logs
WIR	on a wire, such as power-lines
OTH	other, specify in Comments (column 73)

Code	*Coastal*
SUB	Subtidal — area below the lower low tide (chart datum) and is permanently covered by brackish or marine water. Substrates may vary and submergent and/or floating aquatic plants may be present.

Subtidal areas may be described more specifically by one of the following two habitat descriptions:

SSO	Deep subtidal — offshore areas where water depth is greater than 10 m at low tide. The area may support submergent and floating vegetation. Salinity may vary considerably through the water column.
SSS	Shallow subtidal — offshore areas between low tide and 10 m below low tide. The area may support submergent and floating vegetation. Salinity may vary considerably through the water column.
INT	Intertidal — the areas of tidal influence occurring between low low tide, and mean high tide. Mean high tide can be recognized as the line immediately below the zone of driftlogs and below which woody vegetation does not usually occur.

Intertidal habitats may be described more specifically by one of the following habitat descriptions:

IBF	Intertidal beach face/berm — an accumulation of unconsolidated materials within the upper intertidal zone at about the mean high water line of a beach. These are often ephemeral and of variable width. The berm is usually flat (although it may slope gently landwards), while the beach face normally slopes gently seawards. Annual plants may colonize such areas, but permanent vegetation is rarely established.
ICT	Intertidal tide channel — channels resulting from, and dominated by tidal processes. These drain the intertidal portion of the area and are often characterized by silty, organic bed materials and steep banks. Emergent and submergent vegetation are often present.
IFL	Intertidal flats — low gradient intertidal components that do not support significant (<15%) vascular vegetation. They often support diverse macro, micro and meso drift algae. Bars and troughs may be present in some situations.
IMA	Intertidal marsh — a generally low gradient area that supports significant (>15%), non-woody, vascular vegetation for at least part of the year, and is characterized by a surface accumulation of organic material deposited in water.
IPP	Intertidal pond or pool — contains standing water at low tide.
IRS	Intertidal rocky shore — contains bedrock outcrops.
ISC	Intertidal side channel — channel formed by fluvial processes and connected to the main river or stream. Current velocities and depth may vary considerably in relation to season and tide, however, the major influencing factors are riverine.

Distance to Water/Land (columns 62-63)

The average distance to nearest land or water should be indicated by one of the following codes in column 62.

Code	*Distance*
1	<1 m
2	1 – 5 m
3	6 – 10 m
4	11 – 100 m
5	>100 m

The distance code should be followed in column 63 by the code "L" for land, or "W" for water indicating the location of the animal(s).

Season of Use (columns 64 — 65)

Indicate (when known) the season of primary use by the rated wildlife species using the following codes:

Code	*Modifier*	*Code*	*Season*
E	early	P	Spring
M	mid	S	Summer
L	late	F	Fall
		W	Winter
		A	All Seasons
		U	Unknown

Either one season of use can be recorded left justified (e.g., P for spring), or one season with modifier (e.g., LW for late winter use), or two seasons (e.g., PS for Spring and Summer use) can be entered.

Habitat Use (column 66)

Indicate the primary use of the main habitat unit being described using the following codes:

Code	*Habitat Use*
C	cover (general)
D	denning
F	feeding
H	hiding cover
L	mineral licks
M	migration
N	natality
T	thermal cover (from heat or cold)
W	water (drinking)
O	other (specify, using "comment" column 73)

Forage Species (columns 67-72)

Appropriate codes for up to three forage species may be entered in descending order of importance. Codes for common ungulate forage species are presented in Table 6.1. Because summer forage is not generally limiting to ungulates, the table includes only those that are considered to be key winter forage species. A relative importance value is also included to assist the investigator. Codes for common waterfowl forage species are presented in Table 6.2.

The first letter of the genus and species are used to develop the two-letter forage species codes. If no species name is listed (i.e., *spp.* is given), the first two letters of the genus is used. If a conflict exists, the first non-conflicting genus letter is used. These cases are identified in Tables 6.1 and 6.2.

Codes from the ungulate forage list may not be used for the waterfowl forage species list, and vice versa, as conflicts in code exist. If the investigator wishes to record other forage species, or forage species for other wildlife species such as birds, entries may either be recorded as comments, or project specific numeric codes developed.

Table 6.1 Codes for key winter forage plants for B.C. ungulates (from Blower, 1982)

Code	Scientific Name	Common Name	Black-Tailed Deer	Mule Deer	White-Tailed Deer	Mtn. Goat	Big-horn Sheep	Roose-velt Elk	Rocky Mtn. Elk	Moose	Cari-bou
AB	*Abies* spp.	true firs (balsam)	2	2	3	2	3	2	2	2	2
AC	*Acer circinatum*	vine maple	1	3	3	2	3	3	3	3	3
AG	*Acer glabrum*	Douglas maple	2	1	2	1	2	2	1	2	3
AR*	*Agropyron* spp.	wheatgrasses	3	2	2	1	1	3	1	3	2
AL	*Alectoria* spp.	arboreal alectoria lichen	1	1	2	2	3	2	3	3	1
AA	*Amelanchier alnifolia*	saskatoon	3	1	1	2	2	3	1	1	3
AM	*Arbutus menziesii*	arbutus	1	3	3	3	3	2	3	3	3
AU	*Arctostaphlos uva-ursi*	kinnikinnick (bearberry)	3	1	2	2	2	3	3	3	3

Table 6.1 Codes for key winter forage plants for B.C. ungulates (from Blower, 1982) — *Continued*

Code	Scientific Name	Common Name	Black-Tailed Deer	Mule Deer	White-Tailed Deer	Mtn. Goat	Big-horn Sheep	Roose-velt Elk	Rocky Mtn. Elk	Moose	Cari-bou
AF	*Artemisia frigida*	pasture sage	3	1	2	3	1	3	2	3	3
AT	*Artemisia tridentata*	big sagebrush	3	2	3	3	2	3	2	3	3
AH*	*Athyrium* spp.	lady ferns	2	3	3	1	2	3	3	3	3
BG	*Betula glandulosa*	scrub birch (glandular birch)	3	3	3	3	3	3	2	1	2
BO	*Betula occidentalis*	water birch (western birch)	3	2	3	3	3	3	2	1	3
BP	*Betula papyrifera*	paper birch	3	2	3	2	3	3	2	1	2
BS	*Blechnum spicant*	deer fern	2	3	3	3	3	1	3	3	3
BR	*Bromus* spp.	brome grasses	3	2	3	3	2	3	1	3	3
BY	*Bryoria* spp.	arboreal bryoria lichen	1	1	2	2	3	2	3	3	1
CA	*Carex* spp.	sedges	3	2	2	2	1	2	2	1	1
CS	*Ceanothus sanguineus*	redstem ceanothus	1	1	2	2	3	3	2	2	3
CV	*Ceanothus velutinus*	snowbrush	3	1	2	2	3	3	2	2	3
CE	*Cetraria* spp.	arboreal cetraria lichen	2	2	3	2	3	2	3	3	1
CN	*Chrysothamnus nauseosus*	rabbitbrush	3	2	3	3	2	3	2	3	3
CD	*Cladina* spp.	cladina lichens	3	3	3	3	2	3	2	3	1
CL	*Cladonia* spp.	cladonia lichens	3	3	3	3	2	3	2	3	1
CO*	*Cornus sericea*	red-osier dogwood	2	2	2	1	3	1	2	1	2
CR*	*Corylus* spp.	hazelnuts (filberts)	3	2	2	3	3	3	3	2	3
FE	*Festuca* spp.	fescue grasses	3	3	3	1	1	3	1	3	2
GS	*Gaultheria shallon*	salal	1	3	3	3	3	1	3	3	3
HD	*Holodiscus discolor*	ocean-spray	2	2	3	3	3	3	3	3	3
JC	*Juniperus communis*	common juniper	3	2	3	2	3	3	2	3	3
KM	*Koeleria macrantha*	junegrass	3	2	3	2	2	3	3	3	3
LI	*Lonicera involucrata*	black twinberry	3	3	3	2	3	2	3	2	3
LU	*Lupinus* spp.	lupines	3	2	2	3	2	3	2	3	3
MA	*Mahonia* spp.	Oregon-grapes	2	2	2	2	2	2	2	3	3
MF	*Menziesia ferruginea*	false azalea	2	3	3	3	3	2	3	3	3
OH	*Oplopanax horridus*	devil's club	3	3	3	3	3	1	2	3	3
PM	*Paxistima myrsinites*	falsebox	3	1	2	1	3	3	2	1	1
PE	*Penstemon* spp.	penstemons	3	1	2	2	3	3	3	3	3
PL	*Philadelphus lewisii*	mock-orange	3	2	2	3	3	3	2	3	3
PH	*Physocarpus capitalis*	ninebark	2	3	3	3	3	2	3	3	3
PO	*Poa* spp.	bluegrasses	3	2	2	3	3	3	2	2	3
PT	*Populus tremuloides*	trembling aspen	3	3	2	2	2	1	3	2	3
PB	*Populus balsamifera*	balsam poplar/black cottonwood	2	2	2	3	3	3	1	2	3
PR	*Prunus* spp.	wild cherries	2	2	2	2	3	2	2	3	3
PS*	*Pseudotsuga menziesia*	Douglas-fir	3	3	2	2	1	3	2	3	3
PU*	*Purshia tridentata*	antelope-brush (bitterbrush)	3	2	2	3	3	3	1	2	3
RP	*Rhamnus purshianus*	cascara	1	3	3	3	3	2	2	3	3
RG	*Rhus glabra*	sumac	3	1	2	3	2	3	3	3	3
RI	*Ribes* spp.	currants/gooseberries	2	3	3	3	3	2	3	3	3
RO	*Rosa* spp.	roses	2	2	2	3	3	2	2	3	3
RB*	*Rubus pedatus*	five-leaved bramble	2	3	2	3	3	2	3	3	2
RS	*Rubus spectabilis*	salmonberry	2	3	3	3	3	3	3	3	3
RU	*Rubus ursinus*	trailing blackberry	1	3	3	3	3	2	3	3	3
SA	*Salix* spp.	willows	2	2	2	1	3	2	2	1	2
SM*	*Sambucus* spp.	elderberries	2	3	3	3	3	1	2	3	3
SO	*Sorbus* spp.	mountain-ashes	3	3	3	3	3	2	3	1	2
SY	*Symphoricarpus* spp.	snowberries	3	2	3	3	3	3	2	3	3
TB	*Taxus brevifolia*	western yew	2	3	3	3	3	2	3	2	3
TP	*Thuja plicata*	western redcedar	1	3	2	3	3	2	3	2	3
TH	*Tsuga heterophylla*	western hemlock	2	3	3	3	3	1	3	3	3
VA	*Vaccinium* spp.	huckleberries/blueberries	1	3	3	3	3	2	2	2	3
VE	*Viburnum edule*	highbush-cranberry	3	3	3	2	3	2	3	2	3

* Code does not follow rules outlined in text. ** Ranking code: 1 — high importance 2 — moderate importance 3 — low importance

Table 6.2 Codes for common waterfowl forage species

Codes	Scientific Name	Common Name
AG	*Agrostis* spp.	bentgrasses
BS	*Brasenia schreberi*	watershield
CA	*Carex* spp.	sedges
CE	*Ceratophyllum* spp.	hornworts
EL	*Elodea* spp.	waterweeds
EC	*Echinochloa* spp.	barnyard grasses
EN	*Enteromorpha* spp.	sea confetti
LE	*Lemna* spp.	duckweeds
MS	*Medicago sativa*	alfalfa
MY	*Myriophyllum* spp.	water-milfoils
NU	*Nuphar latea*	yellow waterlily
NY	*Nymphaea* spp.	waterlilies
PO	*Polygonum* spp.	knotweeds/smartweeds
PT*	*Potomogeton* spp.	pondweeds
RN	*Ricciocarpus natans*	floating liverwort
RM	*Ruppia maritima*	ditch-grass
SA	*Sagittaria* spp.	arrowheads
SL*	*Salicornia* spp.	glassworts
SC	*Scirpus* spp.	bulrushes
SP	*Sparganium* spp.	bur-reeds
SI*	*Spirodela polyrhiza*	great duckweed
UL	*Ulva* spp.	sea lettuces
VA	*Vallisneria* spp.	tape-grasses
ZA	*Zizania aquatica*	wild-rice
ZO	*Zostera marina*	eel-grass

* Code does not follow rules outlined in text

Comments (column 73)

This column can be used to further describe habitat related information according to the procedure described previously for Comments (column 42).

HABITAT FACTORS (columns 74-87)

This section is oriented towards gathering information necessary for estimating the present and potential wildlife carrying capacity of a site. Wildlife carrying capacity depends on many factors, some of which are site or herd specific. Some major common factors considered in rating present carrying capacity and capability (carrying capacity under ideal seral conditions) used in biophysical wildlife capability classification (Demarchi *et al.*, 1983) are: proximity to human activity; winter snow depth; general landform type; the ability of the area to produce suitable forage species; present and potential productivity of forage species; presence of suitable vegetative cover; and the presence of escape terrain or escape cover. Two further factors important in rating capability, but not present carrying capacity, are (1) the ease of maintaining the vegetative cover in a seral state suitable for the wildlife species being considered; and (2) the potential productivity of forage.

Information for coding these habitat factors for each wildlife species listed on the data form follows.

Distance to Human Activity (column 74)

Enter the code that best reflects the distance of the habitat unit to relatively active and prolonged human activity that may affect the wildlife species.

Code	*Distance to Human Activity*
1	0 — 100 m
2	>100 — 250 m
3	>250 m — 1 km
4	>1 — 5 km
5	>5 km

Type of Human Activity (column 75)

Enter one of following codes that best reflects the type of human activity considered in the previous column.

Code	*Type of Human Activity*	*Code*	*Type of Human Activity*
A	airport	N	narrow unmaintained roads
C	clearcut logging	P	permanent secondary road
D	development roads (logging & mining), actively maintained	R	railroad
F	farm	S	settlement (city, town, village)
H	highway	T	transmission line, pipeline
L	active logging	U	rural
M	mine site	O	other (specify in comments, column 87)

Snow (column 76)

The depth of snow which limits ungulate use varies with snow quality, forage type, and ungulate species, age and sex. Values specified as limiting are therefore only approximate guides. Under average conditions, critical snow depths for ungulate species are generally as follows: 0.5 m for mountain goats, mountain sheep and deer; 0.75 m for elk; and 1 m for caribou and moose (Blower, 1971).

Some other factors to be considered in determining the snow codes are: intensified solar radiation, windsweeping, and presence of permanent snow fields (Demarchi *et al.*, 1983). Temperature factors that affect snowpack duration should also be taken into account. Snow factors can be coded as follows:

Code	*Snow Factors*
1	Low snow depths — snow exceeds critical depths for the species under consideration in <5% of years (<1 year in 20).
2	Moderate snow depths — snow exceeds critical depths for the species under consideration in 5-25% of years (1-5 years in 20).
3	Moderately high snow depth — snow exceeds critical depths for the species under consideration in 25-50% of years (5-10 years in 20).
4	High snow depth — snow exceeds critical depths for species under consideration in 50-75% of years (10-15 years in 20).
5	Very high snow depth — snow exceeds critical depth for the species under consideration for 75-95% of years (15-19 years in 20).
6	Extremely high snow depth — snow exceeds critical depth for the species under consideration in 95-100% of years (>19-20 years).

Landform (column 77)

Wildlife respond in species specific ways to landform configuration. Studies of cattle, elk, and mule deer competition, for instance, have shown that these species use, in that respective order, progressively steeper terrain (Julander and Jeffery, 1964; Mackie, 1970). White-tailed deer on the other hand, tend to select bottom lands (Mackie, 1970), as do moose.

Most desirable (i), and least desirable (ii) terrain features for various big game species are described below:

Moose: (i) A floodplain adapted species with a broad tolerance for rolling and moderately steep terrain, moose may be locally abundant in rolling alpine habitat, particularly during the summer.

(ii) Extremely rough terrain, such as talus slopes and rock bluffs, and slopes with gradients greater than 100%, are avoided.

Elk: (i) A species with a broad tolerance to many different types of landforms. Ideal landforms range from floodplain areas with adjacent river "breaks" to steep avalanche tracks that have greater than 100% slope.

(ii) Talus slopes and rock bluffs are avoided.

Black-tailed Deer: (i) Broad landform tolerance as they occupy level to extremely steep coastal mountain situations. Ideal habitat includes steep areas with small rock outcroppings. Of the American *Cervidae*, black-tailed deer utilize the steepest terrain.

(ii) Areas of extensive rock bluffs are avoided.

Interior Mule Deer: (i) Broad tolerance for a variety of landform types. Mule deer can occupy level to very steep, mountainous terrain. This is a deer of steep, broken terrain, and floodplains, with a preference for rolling to mountainous landforms. Summer habitat is typically alpine, with migration to valley bottoms and lower slopes for the winter. Steep, south facing slopes are ideal early spring range as such areas "green up" quickly.

(ii) Mule deer avoid extensive flat areas that are devoid of trees or rock bluffs.

White-tailed Deer: (i) Compared to mule deer, white-tailed deer usually favour flatter land. In British Columbia they are generally restricted to floodplains and lower mountain slopes and terraces.

(ii) White-tailed deer avoid areas of extensive, steep slopes, alpine habitats, and steep, rocky areas.

Mountain Sheep: (i) Thinhorn and bighorn sheep are mountain animals always associated with steep slopes. They forage on flat terrain if steep, escape terrain (slopes greater than 100%) is nearby (within 0.5 km). Summer range is often alpine tundra. Most bighorn sheep and some thinhorn sheep descend to lower, drier, southern facing slopes in winter.

(ii) Mountain sheep avoid extensive, flat areas and floodplains.

Mountain Goats: (i) Mountain goats inhabit steep, rocky, mountainous terrain. They prefer steep, alpine, talus areas at the base of cliffs, but may also frequent narrow ledges on the face of steep cliffs or rocky ridges, or rolling alpine meadows adjacent to rugged escape terrain (Banfield, 1974).

(ii) Mountain goats avoid areas that are devoid of rugged escape terrain, such as floodplains, extensive flat or rolling areas, and most lower mountain areas.

Caribou: (i) Caribou are essentially an alpine/subalpine species. They prefer broad rolling areas, but the cows often calve on steep, narrow, rocky terrain. Considerable foraging can occur in marshes, bogs or subalpine forests. Caribou also have a broad tolerance to a variety of landforms when they are migrating between summer and winter ranges.

(ii) Caribou avoid rock bluffs.

Grizzly Bears: (i) Grizzlies prefer landforms that produce wet ecosystems, such as floodplains, seeps, avalanche tracks and subalpine meadows. In spring they concentrate in areas that provide early, succulent plant growth, such as that on floodplains and avalanche tracks; in fall they concentrate in areas that provide abundant energy sources, such as berry patches and salmon spawning streams. Denning occurs in micro-sites with deep soils and adequate snow cover, or in bedrock caves.

(ii) Grizzlies avoid landforms that produce dry ecosystems, such as dry alpine areas, dry forests, rock bluffs and talus.

Landform factors are determined on a scale of 1 to 6 for each species. Ideal landform types are considered unlimiting and are coded as 1, while unsuitable landforms are coded as 6. The six categories are:

Code	*Landform Factor*
1	Landforms are ideal or nearly ideal.
2	Use of the area is slightly reduced (75-95% of potential) by landform factors.
3	Use of the area is moderately reduced (50-75% of potential) by landform factors.
4	Use of the area is severely reduced (25-50% of potential) by landform factors. Factors resulting in this situation include steep terrain hindering locomotion of the specific species, or for those species associated with mountains, the lands have less than sufficient slope to provide escape terrain.
5.	Use of the area is extremely reduced (5-25% of potential) by landform factors. An example is steep terrain that severely limits mobility of many big game species (or flat or rolling land, in the case of mountain sheep and mountain goats).
6	Capability is almost nil because of unsuitable landforms (<5% of potential). Examples include extremely steep terrain for *cervidae*, or flatlands in the case of mountain sheep and mountain goats.

Present Adjacent Escape Terrain/Cover (column 78)

This parameter is divided into two sections because of the two distinct types of escape habitat utilized by ungulates. Mountain goat and mountain sheep utilize rugged terrain to escape predators; moose, elk, and white-tailed deer use vegetative cover; and caribou and mule deer may utilize either. Because of this, two rating schemes have been developed: one for terrain used for escape, and the other for vegetative cover used. Enter the appropriate code for the most limiting factor (i.e., either escape terrain or cover).

Some ungulate species are dependent on combinations of landforms rather than simple units. Mountain goats and mountain sheep, for example, seldom forage far from steep cliffs (escape terrain). Codes for presence of adjacent escape terrain follow:

Code	*Adjacent Escape Terrain*
1	The use of the area represented by the sample plots is not limited significantly by type, form, or proximity of escape terrain.
2	Use of the area represented by the sample plots is slightly reduced (75-95% of potential) by the type of adjacent escape terrain.
3	Use of the area represented by the sample plots is moderately reduced (50-75% of potential) by the type of adjacent escape terrain.
4	Use of the area represented by the sample plots is severely reduced (25-50% of potential) by the type of adjacent escape terrain. Some examples are areas with marginal adjacent escape terrain for mountain sheep and mountain goats, or escape terrain that is too distant.
5	Use of the area represented by the sample plots is very severely reduced (5-25% of potential) by lack of adjacent escape terrain. An example is areas distant from suitable escape terrain for mountain goats and mountain sheep.
6	Inadequate escape terrain precludes the use of the area by the wildlife species under consideration. An example is lack of escape terrain for mountain goats and mountain sheep.

Species such as elk, deer, moose and grizzly bear rely on cover (forests) rather than terrain for escape habitat. An area being described may lack escape cover, but this deficiency can be compensated by an adjacent area described in other sample plots. Codes for escape cover follow:

Code	*Escape Cover*
1	Present adjacent cover does not significantly affect the potential of the area being rated.
2	The lack of ideal adjacent cover slightly reduces the use of the area (75-95% of potential).
3	The lack of ideal adjacent cover moderately reduces (50-75% of potential) the use of the area.
4	The lack of ideal adjacent cover severely reduces (25-50% of potential) the use of the area.
5	The lack of ideal adjacent cover extremely reduces (5-25% of potential) the use of the area.
6	The lack of ideal adjacent cover precludes use of the area.

Present Forage Production (column 79)

This parameter identifies the current forage production on a site. The rating scale is derived from the forage capability classification developed by Demarchi and Harcombe (1982), but the ratings are for existing rather than ideal seral situations. The scale and appropriate codes are as follows:

Code	*Present Forage Production*
1	Production of herbaceous plants, lichens, and/or browse is very high. Production is greater than 1000 kg/ha/yr of herbage; or plant cover is 50-100% browse plants or terrestrial lichens; or arboreal lichen biomass is greater than 1000 kg/ha.
2	Production of herbaceous plants, lichens, and/or browse is high. Production is between 500 and 1000 kg/ha/yr of herbage; or plant cover is 25 to 50% browse plants or terrestrial lichens; or arboreal lichen biomass is 500 to 1000 kg/ha.
3	Production of herbaceous plants, lichens, and/or browse is moderate. Production is 225 to 500 kg/ha/yr of herbage; or plant cover is 10 to 25% browse plants or terrestrial lichens; or arboreal lichen biomass is 225 to 500 kg/ha.
4	Production of herbaceous plants, lichens and/or browse is low. Production is from 110 to 225 kg/ha/yr of herbage; or plant cover is 5 to 10% browse plants or terrestrial lichens; or arboreal lichen biomass is 110 to 225 kg/ha.
5	Production of herbaceous plants, lichens and/or browse is very low to none. Production is less than 110 kg/ha/yr of herbage; or plant cover is less than 5% browse plants or terrestrial lichens; or arboreal lichen biomass is less than 110 kg/ha.

Potential Forage Production (column 80)

The forage capability classification, developed by Demarchi and Harcombe (1982), assesses the potential of a site to produce given quantities of forage. Potential forage production is rated on a scale of 1 to 5 as follows:

Code	*Potential Forage Production*
1	Capability to produce herbaceous plants, lichens, and/or browse is very high. Production can be greater than 1000 kg/ha/yr of herbage; or plant cover can be 50 to 100% browse plants or terrestrial lichens; or arboreal lichens biomass can be greater than 1000 kg/ha.
2	Capability to produce herbaceous plants, lichens, and/or browse is high. Production can be 500 to 1000 kg/ha/yr of herbage; or plant cover can be 25 to 50% browse plants or terrestrial lichens; or arboreal lichen biomass can be 500 to 1000 kg/ha.
3	Capability to produce herbaceous plants, lichens, and/or browse is moderate. Production can be 225 to 500 kg/ha/yr of herbage; or plant cover can be 10 to 25% browse plants or terrestrial lichens; or arboreal lichen biomass can be 225 to 500 kg/ha.
4	Capability to produce herbaceous plants, lichens, and/or browse is low. Production can be 110 to 225 kg/ha/yr of herbage; or plant cover can be 5 to 10% browse plants or terrestrial lichens; or arboreal lichen biomass can be 110 to 225 kg/ha.
5	Capability to produce herbaceous plants, lichens, and/or browse is very low to none. Production can be up to 110 kg/ha/yr of herbage; or plant cover can be up to 5% browse plants or terrestrial lichens; or arboreal lichen biomass can be up to 110 kg/ha.

Maintenance of Optimal Seral Condition (column 81)

Habitat enhancement may be required to keep an area productive for wildlife. The degree of manipulation required is rated as follows:

Code	*Habitat Enhancement*
1	Enhancement is not required, except, perhaps, minor management such as burning every 50 to 100 years.
2	Moderate enhancement is required; occasional burning or clearing on 20 to 50 year intervals.
3	Relatively frequent enhancement is required; either burning or clearing every 10 to 20 years, or special burning techniques such as burns in consecutive years are required.
4	Frequent enhancement is required; for example, burning or clearing every 5 to 10 years.
5	Very frequent enhancement is required; for example, burning or clearing every 2 to 5 years.
6	Enhancement treatments are impractical.

Enhancement Objective (column 82)

The primary objective of habitat enhancement is recorded here using the following codes:

Code	*Enhancement Objective*
C	improve cover conditions in general
F	improve forage conditions
H	improve hiding cover
T	improve thermal cover (from heat or cold)
O	other, specify in comments in column 87
N	none, no enhancement needed

Enhancement Potential (column 83)

The relative potential to enhance the habitat is recorded using the following codes. Enhancement potential is a function of both the expected benefits to the specific wildlife species and the relative cost or ease of accomplishing the enhancement.

Code	*Enhancement Potential*
H	high
M	moderate
L	low
N	nil
O	habitat is already in optimum condition; maintenance of existing conditions is the management objective.

Enhancement Technique Suggested (column 84)

The main enhancement technique that should be considered is recorded here using the following codes. If more than one technique is applicable, specify them in Comments, column 87.

Code	*Enhancement Technique*
B	burning (prescribed fire)
C	clearcut logging (to promote forage)
F	fertilization
G	manipulation of forage by domestic livestock
L	selective logging
M	maintainence of site, no management
P	planting or seeding of forage species
R	reduction of range use by domestic livestock
S	shrub cutting
T	planting tree species for future cover needs
O	other, specify in Comments, column 87

Present Suitability and Capability (columns 85 and 86)

Present suitability is the ability of a specified habitat, in its' current state, to produce a given number of animals of a particular species. Capability is the potential of a specified area, in an optimal successional stage, to produce a given number of animals of a particular species. For capability, management inputs of a low technological order such as prescribed burning, livestock control, prescribed logging, or protection from deleterious land practices are assumed. For more details on these concepts see Demarchi *et al.*, (1983) and Hills *et al.*, (1973).

Density estimates shown on Table 6.3 represent the numbers of each ungulate species that a square kilometre of a specified habitat can support for one month. If the period of use is longer than one month, then the number of animals predicted are divided by the number of months of use in order to determine the class. For example, on one square kilometre of class 1A habitat, there could be 156 elk for 1 month, 26 elk for 6 months or 13 elk for 1 year. An alternative concept, shown on Table 6.4, is the value of habitat expressed as the amount of land of a particular habitat that is required to support one animal of each wildlife species for one month (hectares/animal/month).

If the number of animals, period of use and the area of the habitat is known, use Table 6.3 to determine the *tentative* suitability/capability class rating. If the value of the habitat, the area of the habitat and the period of use is known, use Table 6.4 in order to determine the *tentative* suitability/capability class rating. Enter the codes for the appropriate classes for the designated species in the suitability column (85) and capability column (86). Note that "tentative" is used because several parameters from all other habitats within a study area, and usually unobservable from only one plot, must be considered in determining the final suitability/capability class rating.

For grizzly bears, the suitability/capability class ratings (from Fuhr and Demarchi, 1990) are as follows:

Code	*Suitability/Capability Class*	
H	High	<10 km^2/grizzly bear
M	Moderate	10-39 km^2/grizzly bear
L	Low	>39 km^2/grizzly bear
N	Nil	—

Table 6.3 Potential density estimates for each class rating for each wildlife species (animals/square kilometre/month)*

Code	Class	Proportions	Black-tailed Deer	Mule Deer White-tailed Deer	Mountain Sheep	Elk	Caribou	Mountain Goat	Moose
C	1C	126–150%	406–486	316–378	241–288	196–234	151–180	106–126	91–108
B	1B	101–125%	325–405	253–315	193–240	157–195	121–150	85–105	73–90
1	1A	76–100%	244–324	190–252	145–192	118–156	91–120	64–84	55–72
2	2	51–75%	163–243	127–189	97–144	79–117	61–90	43–63	37–54
3	3	26–50%	82–162	64–126	49–96	40–78	31–60	22–42	19–36
4	4	6–25%	17–81	14–63	11–48	9–39	7–30	5–21	5–18
5	5	<5%	1–16	1–13	1–10	1–8	1–6	1–4	1–4
6	6	nil	0	0	0	0	0	0	0

* For use with both ungulate suitability (column 85), and ungulate capability (column 86) ratings (after data in Demarchi *et al.*, 1983).

Table 6.4 The value of habitat expressed as the amount of land that is required to support one animal of a specified wildlife species for one month (hectares/animal/month)*

Code	Class	Proportions	Black-tailed Deer	Mule Deer White-tailed Deer	Mountain Sheep	Elk	Caribou	Mountain Goat	Moose
C	1C	126–150%	0.21–0.25	0.27–0.3	0.3–0.4	0.4–0.5	0.5–0.6	0.8–1.0	0.9–1.1
B	1B	100–125%	0.25–0.3	0.3–0.4	0.4–0.5	0.5–0.6	0.6–0.8	1.0–1.2	1.1–1.4
1	1A	75–100%	0.3–0.4	0.4–0.5	0.5–0.7	0.6–0.8	0.8–1.1	1.2–1.6	1.4–1.8
2	2	50–75%	0.4–0.6	0.5–0.8	0.7–1.0	0.8–1.2	1.1–1.6	1.6–2.4	1.8–2.8
3	3	25–50%	0.6–1.2	0.8–1.6	1.0–2.0	1.2–2.4	1.6–3.2	2.4–4.8	2.8–5.6
4	4	5–25%	1.2–6.0	1.6–8.0	2.0–10.0	2.4–12.0	3.2–16.0	4.8–24.0	5.6–28.0
5	5	<5%	>6.0	>8.0	>10.0	>12.0	>16.0	>24.0	>28.0
6	6	nil	unsuited	unsuited	unsuited	unsuited	unsuited	unsuited	unsuited

* For use with both ungulate suitability (column 85) and ungulate capability (column 86) ratings (after data in Demarchi *et al.*, 1983).

Comments (column 87)

This column is used following the procedures previously outlined for Comments (column 42).

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990)

AMPHIBIANS AND REPTILES		
Salamanders	Order Caudata	*Code*
Northwestern Salamander	*Ambystoma gracile*	A-AMGR
Long-toed Salamander	*Ambystoma macrodactylum*	A-AMMA
Tiger Salamander	*Ambystoma tigrinum*	A-AMTI
Clouded Salamander	*Aneides ferreus*	A-ANFE
Pacific Giant Salamander	*Dicamptodon ensatus*	A-DIEN
Ensatina Salamander	*Ensatina eschscholtzii*	A-ENES
Western Red-backed Salamander	*Plethodon vehiculum*	A-PLVE
Rough-skinned Newt	*Taricha granulosa*	A-TAGR
Unspecified Salamander	(unspecified)	A-USAL
Couer d'Alene Salamander	*Plethodon idahoensis*	A-PLID
Frogs and Toads	Order Anura	
Tailed Frog	*Ascaphus truei*	A-ASTR
Western Toad	*Bufo boreas*	A-BUBO
Pacific Treefrog	*Hyla regilla*	A-HYRE
Striped Chorus Frog	*Pseudacris triseriata*	A-PSTR
Red-legged Frog	*Rana aurora*	A-RAAU
American Bullfrog	*Rana catesbeiana*	A-RACA
Green Frog	*Rana clamitans*	A-RACL
Northern Leopard Frog	*Rana pipiens*	A-RAPI
Spotted Frog	*Rana pretiosa*	A-RAPR
Wood Frog	*Rana sylvatica*	A-RASY
Great Basin Spadefoot Toad	*Scaphiopus intermontanus*	A-SCIN
Unspecified Frog	(unspecified)	A-UFRO
Turtles	Order Testudines	
Green Sea Turtle	*Chelonia mydas*	R-CHMY
Painted Turtle	*Chrysemys picta*	R-CHPI
Reeves' Turtle	*Chinemys reevesii*	R-CHRE
Snapping Turtle	*Chelydra serpentina*	R-CHSE
Western Pond Turtle	*Clemmys marmorata*	R-CLMA
Leatherback Sea Turtle	*Dermochelys coriacea*	R-DECO
Unspecified Turtle	(unspecified)	R-UTUR
Lizards	Order Squamata	
Western Skink	*Eumeces skiltonianus*	R-EUSK
Northern Alligator Lizard	*Gerrhonotus coeruleus*	R-GECO
Short-horned Lizard	*Phrynosoma douglassii*	R-PHDO
Snakes	Order Serpentes	
Rubber Boa	*Charina bottae*	R-CHBO
Western Yellow-bellied Racer	*Coluber mormon*	R-COMO
Sharp-tailed Snake	*Contia tenuis*	R-COTE
Western Rattlesnake	*Crotalus viridis*	R-CRVI
Night Snake	*Hypsiglena torquata*	R-HYTO
Gopher Snake	*Pituophis melanoleucus*	R-PIME
Western Garter Snake	*Thamnophis elegans*	R-THEL
Northwestern Garter Snake	*Thamnophis ordinoides*	R-THOR
Common Garter Snake	*Thamnophis sirtalis*	R-THSI
Unspecified Snake	(unspecified)	R-USNA

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

MAMMALS		
Primates	Order Primates	*Code*
Man	*Homo sapiens*	M-HOSA
Marsupials	Order Marsupialia	
North American Opossum	*Didelphis virginiana*	M-DIVI
Insectivores	Order Insectivora	
Shrew-mole	*Neurotrichus gibbsii*	M-NEGI
Coast Mole	*Scapanus orarius*	M-SCOR
Townsend's Mole	*Scapanus townsendii*	M-SCTO
Black-backed Shrew	*Sorex arcticus*	M-SOAR
Pacific Water Shrew	*Sorex bendirii*	M-SOBE
Common Shrew	*Sorex cinereus*	M-SOCI
Pygmy Shrew	*Sorex hoyi*	M-SOHO
Dusky Shrew	*Sorex monticolus*	M-SOMO
Water Shrew	*Sorex palustrus*	M-SOPA
Trowbridge's Shrew	*Sorex trowbridgii*	M-SOTR
Tundra Shrew	*Sorex tundrensis*	M-SOTU
Vagrant Shrew	*Sorex vagrans*	M-SOVA
Unspecified Mole	(unspecified)	M-UMOL
Unspecified Shrew	(unspecified)	M-USHR
Bats	Order Chiroptera	
Pallid Bat	*Antrozous pallidus*	M-ANPA
Big Brown Bat	*Eptesicus fuscus*	M-EPFU
Spotted Bat	*Euderma maculatum*	M-EUMA
Southern Red Bat	*Lasiurus blossevilli*	M-LABL
Hoary Bat	*Lasiurus cinereus*	M-LACI
Silver-haired Bat	*Lasionycteris noctivagans*	M-LANO
California Myotis	*Myotis californicus*	M-MYCA
Western Long-eared Myotis	*Myotis evotis*	M-MYEV
Northern Long-eared Myotis	*Myotis septentrionalis*	M-MYSE
Keen's Long-eared Myotis	*Myotis keenii*	M-MYKE
Western Small-footed Myotis	*Myotis ciliolabrum*	M-MYCI
Little Brown Myotis	*Myotis lucifugus*	M-MYLU
Fringed Myotis	*Myotis thysanodes*	M-MYTH
Long-legged Myotis	*Myotis volans*	M-MYVO
Yuma Myotis	*Myotis yumanensis*	M-MYYU
Townsend's Big-eared Bat	*Plecotus townsendii*	M-PLTO
Big Free-tailed Bat	*Nyctinomops macrotis*	M-NYMA
Unspecified Bat	(unspecified)	M-UBAT
Pikas, Rabbits and Hares	Order Lagomorpha	
Snowshoe Hare	*Lepus americanus*	M-LEAM
White-tailed Jackrabbit	*Lepus townsendii*	M-LETO
Collared Pika	*Ochotona collaris*	M-OCCO
Common Pika	*Ochotona princeps*	M-OCPR
European Rabbit	*Oryctolagus cuniculus*	M-ORCU
Eastern Cottontail	*Sylvilagus floridanus*	M-SYFL
Nuttall's Cottontail	*Sylvilagus nuttallii*	M-SYNU

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Rodents	Order Rodentia	*Code*
Northern Flying Squirrel	*Glaucomys sabrinus*	M-GLSA
Hoary Marmot	*Marmota caligata*	M-MACA
Yellow-bellied Marmot	*Marmota flaviventris*	M-MAFL
Woodchuck	*Marmota monax*	M-MAMO
Vancouver Island Marmot	*Marmota vancouverensis*	M-MAVA
Columbian Ground Squirrel	*Spermophilus columbianus*	M-SPCO
Golden-mantled Ground Squirrel	*Spermophilus lateralis*	M-SPLA
Arctic Ground Squirrel	*Spermophilus parryii*	M-SPPA
Cascade Mantled Ground Squirrel	*Spermophilus saturatus*	M-SPSA
Yellow-pine Chipmunk	*Tamias amoenus*	M-TAAM
Douglas' Squirrel	*Tamiasciurus douglasii*	M-TADO
Gray Squirrel	*Sciurus carolinensis*	M-SCCA
Fox Squirrel	*Sciurus niger*	M-SCNI
Red Squirrel	*Tamiasciurus hudsonicus*	M-TAHU
Least Chipmunk	*Tamias minimus*	M-TAMI
Red-tailed Chipmunk	*Tamias ruficaudus*	M-TARU
Townsend's Chipmunk	*Tamias townsendii*	M-TATO
Unspecified Chipmunk	(unspecified)	M-UCHP
Mountain Beaver	*Aplodontia rufa*	M-APRU
Beaver	*Castor canadensis*	M-CACA
Porcupine	*Erethizon dorsatum*	M-ERDO
Nutria	*Myocastor coypus*	M-MYCO
Muskrat	*Ondatra zibethicus*	M-ONZI
Southern Red-backed Vole	*Clethrionomys gapperi*	M-CLGA
Northern Red-backed Vole	*Clethrionomys rutilus*	M-CLRU
Brown Lemming	*Lemmus sibiricus*	M-LESI
Long-tailed Vole	*Microtus longicaudus*	M-MILO
Montane Vole	*Microtus montanus*	M-MIMO
Tundra Vole	*Microtus oeconomus*	M-MIOE
Creeping Vole	*Microtus oregoni*	M-MIOR
Meadow Vole	*Microtus pennsylvanicus*	M-MIPE
Water Vole	*Microtus richardsoni*	M-MIRI
Townsend's Vole	*Microtus townsendii*	M-MITO
House Mouse	*Mus musculus*	M-MUMU
Bushy-tailed Woodrat	*Neotoma cinerea*	M-NECI
Deer Mouse	*Peromyscus maniculatus*	M-PEMA
Great Basin Pocket Mouse	*Perognathus parvus*	M-PEPA
Sitka Mouse	*Peromyscus sitkensis*	M-PESI
Columbian Mouse	*Peromyscus oreas*	M-PEOR
Heather Vole	*Phenacomys intermedius*	M-PHIN
Norway Rat	*Rattus norvegicus*	M-RANO
Black Rat	*Rattus rattus*	M-RARA
Western Harvest Mouse	*Reithrodontomys megalotis*	M-REME
Northern Bog Lemming	*Synaptomys borealis*	M-SYBO
Northern Pocket Gopher	*Thomomys talpoides*	M-THTA
Unspecified Jumping Mouse	(unspecified)	M-UJUM
Unspecified Mouse	(unspecified)	M-UMOU
Unspecified Vole	(unspecified)	M-UVOL
Meadow Jumping Mouse	*Zapus hudsonius*	M-ZAHU
Western Jumping Mouse	*Zapus princeps*	M-ZAPR
Pacific Jumping Mouse	*Zapus trinotatus*	M-ZATR

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Carnivores	Order Carnivora	*Code*
Domestic Dog	*Canis familiarius*	M-CAFA
Coyote	*Canis latrans*	M-CALA
Gray Wolf	*Canis lupus*	M-CALU
Northern Fur Seal	*Callorhinus ursinus*	M-CAUR
Sea Otter	*Enhydra lutris*	M-ENLU
Northern Sea Lion	*Eumetopias jubatus*	M-EUJU
Cougar	*Felis concolor*	M-FECO
Domestic Cat	*Felis sylvestris*	M-FESY
Wolverine	*Gulo gulo*	M-GUGU
River Otter	*Lontra canadensis*	M-LOCA
Lynx	*Lynx canadensis*	M-LYCA
Bobcat	*Lynx rufus*	M-LYRU
Marten	*Martes americana*	M-MAAM
Fisher	*Martes pennanti*	M-MAPE
Striped Skunk	*Mephitis mephitis*	M-MEME
Northern Elephant Seal	*Mirounga angustirostris*	M-MIAN
Ermine	*Mustela erminea*	M-MUER
Long-tailed Weasel	*Mustela frenata*	M-MUFR
Least Weasel	*Mustela nivalis*	M-MUNI
Mink	*Mustela vison*	M-MUVI
Harbor Seal	*Phoca vitulina*	M-PHVT
Raccoon	*Procyon lotor*	M-PRLO
Spotted Skunk	*Spilogale putorius*	M-SPPU
Badger	*Taxidea taxus*	M-TATA
Unspecified Bear	(unspecified)	M-UBEA
Black Bear	*Ursus americanus*	M-URAM
Grizzly Bear	*Ursus arctos*	M-URAR
Unspecified Sea Lion	(unspecified)	M-USEL
Unspecified Weasel	(unspecified)	M-UWEA
Red Fox	*Vulpes vulpes*	M-VUVU
California Sea Lion	*Zalophus californianus*	M-ZACA
Ungulates	Order Artiodactyla	
Moose	*Alces alces*	M-ALAL
Northwestern Moose	*Alces alces andersoni*	M-ALAA
Alaska Moose	*Alces acles gigas*	M-ALAG
Yellowstone Moose	*Alces alces shirasi*	M-ALAS
Bison	*Bison bison*	M-BIBI
Domestic Cow	*Bos taurus*	M-BOTA
Domestic Goat	*Capra hircus*	M-CAHI
Fallow Deer	*Cervus dama*	M-CEDA
Elk	*Cervus elaphus*	M-CEEL
Rocky Mountain Elk	*Cervus elaphus nelsoni*	M-CEEN
Roosevelt Elk	*Cervus elaphus roosevelti*	M-CEER
Domestic Horse	*Equus caballus*	M-EQCA
Mule Deer	*Odocoileus hemionus*	M-ODHE
Black-tailed Deer	*Odocoileus hemionus columbianus*	M-ODHC
Interior Mule Deer	*Odocoileus hemionus hemionus*	M-ODHH
Sitka Deer	*Odocoileus hemionus sitkensis*	M-ODHS
White-tailed Deer	*Odocoileus virginianus*	M-ODVI
Mountain Goat	*Oreamnos americanus*	M-ORAM
Domestic Sheep	*Ovis aries*	M-OVAR
Bighorn Sheep	*Ovis canadensis*	M-OVCA

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Ungulates	Order Artiodactyla	*Code*
Unspecified Deer	(unspecified)	M-UDEE
California Bighorn Sheep	*Ovis canadensis californiana*	M-OVCC
Rocky Mountain Bighorn Sheep	*Ovis canadensis canadensis*	M-OVCN
Dall Sheep	*Ovis dalli dalli*	M-OVDD
Stone Sheep	*Ovis dalli stonei*	M-OVDS
Caribou	*Rangifer tarandus*	M-RATA
European Pig	*Sus scofa*	M-SUSS
Thinhorn Sheep	*Ovis dalli*	M-OVDA
Whales and Porpoises	Order Cetacea	
Minke Whale	*Balaenoptera acutorostrata*	M-BAAC
Sei Whale	*Balaenoptera borealis*	M-BABO
Right Whale	*Balaena glacialis*	M-BAGL
Blue Whale	*Balaenoptera musculus*	M-BAMU
Fin Whale	*Balaenoptera physalus*	M-BAPH
North Pacific Bottle-nosed Whale	*Berardius bairdii*	M-BEBA
Gray Whale	*Eschrichtius robustus*	M-ESRO
Hubb's Beaked Whale	*Micropteron carlhubbsi*	M-HBWH
Dwarf Sperm Whale	*Kogia simus*	M-KOSI
Arch-beaked Whale	*Mesoplodon carlhubbsi*	M-MECA
Humpback Whale	*Megaptera novaeangliae*	M-MENO
Bering Sea Beaked Whale	*Mesoplodon stejnegeri*	M-MEST
Sperm Whale	*Physeter macrocephalus*	M-PHMA
Stejnerger's Beaked Whale	*Micropteron stejnergeri*	M-SBWH
Goose-beaked Whale	*Ziphius cavirostris*	M-ZICA
False Killer Whale	*Pseudorca crassidens*	M-PSCR
Saddle-backed Dolphin	*Delphinus delphis*	M-DEDE
Short-finned Pilot Whale	*Globicephala macrorhynchus*	M-GLMA
Risso's Dolphin	*Grampus griseus*	M-GRGR
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	M-LAOB
Northern Right-whale Dolphin	*Lissodelphis borealis*	M-LIBO
Killer Whale	*Orcinus orca*	M-OROR
Dall's Porpoise	*Phocoenoides dalli*	M-PHDA
Harbor Porpoise	*Phocoena phocoena*	M-PHPH
Striped Dolphin	*Stenella coeruleoalba*	M-STCO
Unspecified Dolphin	(unspecified)	M-UDOL
Unspecified Whale	(unspecified)	M-UWHA
BIRDS		
Loons	Order Gaviiformes	
Common Loon	*Gavia immer*	M-COLO
Red-throated Loon	*Gavia stellata*	M-RTLO
Unspecified Loon	(unspecified)	M-ULOO
Yellow-billed Loon	*Gavia adamsii*	M-YBLO
Pacific Loon	*Gavia pacifica*	M-PALO
Grebes	Order Podicipediformes	
Eared Grebe	*Podiceps nigricollis*	M-EAGR
Horned Grebe	*Podiceps auritus*	M-HOGR
Pied-billed Grebe	*Podilymbus podiceps*	M-PBGR
Red-Necked Grebe	*Podiceps grisegena*	M-RNGR
Unspecified Grebe	(unspecified)	M-UGRE
Western Grebe	*Aechmophorus occidentalis*	M-WEGR
Clark's Grebe	*Aechmophorus clarkii*	M-CLGR

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Albatrosses, Shearwaters and Petrels	Order Procellariiformes	*Code*
Black-footed Albatross	*Diomedea nigripes*	B-BFAL
Buller's Shearwater	*Puffinus bulleri*	B-BLSH
Black-vented Shearwater	*Puffinus opisthomelas*	B-BVSH
Flesh-footed Shearwater	*Puffinus carneipes*	B-FFSH
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	B-FTSP
Laysan Albatross	*Diomedea immutabilis*	B-LAAL
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	B-LSPE
Mottled Petrel	*Pterodroma inexpectata*	B-MOPE
Northern Fulmar	*Fulmarus glacialis*	B-NOFU
Pink-footed Shearwater	*Puffinus creatopus*	B-PFSH
Sooty Shearwater	*Puffinus griseus*	B-SOSH
Short-tailed Albatross	*Diomedea albatrus*	B-STAL
Short-tailed Shearwater	*Puffinus tenuirostris*	B-STSH
Unspecified Albatross	(unspecified)	B-UALB
Unspecified Shearwater	(unspecified)	B-USHE
Unspecified Storm-Petrel	(unspecified)	B-USTP
Pelicans and Cormorants	Order Pelecaniformes	
American White Pelican	*Pelecanus erythrorhynchos*	B-AWPE
Brandt's Cormorant	*Phalacrocorax penicillatus*	B-BRCO
Brown Pelican	*Pelecanus occidentalis*	B-BRPE
Double-crested Cormorant	*Phalacrocorax auritus*	B-DCCO
Magnificant Frigatebird	*Fregata magnificens*	B-MAFR
Pelagic Cormorant	*Phalacrocorax pelagicus*	B-PECO
Unspecified Cormorant	(unspecified)	B-UCOR
Red-faced Cormorant	*Phalacrocorax urile*	B-RFCO
Herons, Bitterns and Allies	Order Ciconiiformes	
American Bittern	*Botaurus lentiginosus*	B-AMBI
Black-crowned Night-Heron	*Nycticorax nycticorax*	B-BCNH
Cattle Egret	*Bubulcus ibis*	B-CAEG
Great Blue Heron	*Ardea herodias*	B-GBHE
Great Egret	*Casmerodius albus*	B-GREG
Green-backed Heron	*Butorides striatus*	B-GRHE
Little Blue Heron	*Egretta caerulea*	B-LBHE
Least Bittern	*Ixobrychus exilis*	B-LEBI
Snowy Egret	*Egretta thula*	B-SNEG
White-faced Ibis	*Plegadis chihi*	B-WFIB
Wood Stork	*Mycteria americana*	B-WOST
Waterfowl	Order Anseriformes	
American Black Duck	*Anas rubripes*	B-ABDU
American Wigeon	*Anas americana*	B-AMWI
Barrow's Goldeneye	*Bucephala islandica*	B-BAGO
Baikal Teal	*Anas formosa*	B-BATE
Black Scoter	*Melanitta nigra*	B-BLSC
Brant	*Branta bernicla*	B-BRAN
Bufflehead	*Bucephala albeola*	B-BUFF
Blue-winged Teal	*Anas discors*	B-BWTE
Canada Goose	*Branta canadensis*	B-CAGO
Canvasback	*Aythya valisineria*	B-CANV

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Waterfowl — Continued	Order Anseriformes	*Code*
Cinnamon Teal	*Anas cyanoptera*	B-CITE
Common Eider	*Somateria mollissima*	B-COEI
Common Goldeneye	*Bucephala clangula*	B-COGO
Common Merganser	*Mergus merganser*	B-COME
Domestic/feral duck (Peking)	*Anas platyrhynchos*	B-DODU
Domestic/feral goose (Greylag)	*Anser anser*	B-DOGS
Emperor Goose	*Chen canagica*	B-EMGO
Eurasion Wigeon	*Anas penelope*	B-EUWI
Gadwall	*Anas strepera*	B-GADW
Garganey	*Anas querquedula*	B-GARG
Greater Scaup	*Aythya marila*	B-GRSC
Greater White-fronted Goose	*Anser albifrons*	B-GWFG
Green-winged Teal	*Anas crecca*	B-GWTE
Harlequin Duck	*Histrionicus histrionicus*	B-HADU
Hooded Merganser	*Lophodytes cucullatus*	B-HOME
King Eider	*Somateria spectabilis*	B-KIEI
Lesser Scaup	*Aythya affinis*	B-LESC
Mallard	*Anas platyrhynchos*	B-MALL
Muskovy Duck	*Cairina maschata*	B-MUDU
Mute Swan	*Cygnus olor*	B-MUSW
Northern Pintail	*Anas acuta*	B-NOPI
Northern Shoveler	*Anas clypeata*	B-NOSL
Oldsquaw	*Clangula hyemalis*	B-OLDS
Red-breasted Merganser	*Mergus serrator*	B-RBME
Redhead	*Aythya americana*	B-REDH
Ring-necked Duck	*Aythya collaris*	B-RNDU
Ross' Goose	*Chen rossii*	B-ROGO
Ruddy Duck	*Oxyura jamaicensis*	B-RUDU
Smew	*Mergellus albellus*	B-SMEW
Snow Goose	*Chen caerulescens*	B-SNGO
Steller's Eider	*Polysticta stelleri*	B-STEI
Surf Scoter	*Melanitta perspicillata*	B-SUSC
Trumpeter Swan	*Cygnus buccinator*	B-TRUS
Tufted Duck	*Aythya fuligula*	B-TUDU
Tundra Swan	*Cygnus columbianus*	B-TUSW
Unspecified Dabbling Duck	(unspecified)	B-UDAD
Unspecified Diving Duck	(unspecified)	B-UDID
Unspecified Goldeneye	(unspecified)	B-UGOL
Unspecified Merganser	(unspecified)	B-UMER
Unspecified Scaup	(unspecified)	B-USCA
Unspecified Scoter	(unspecified)	B-USCO
Unspecified Swan	(unspecified)	B-USWN
Unspecified Teal	(unspecified)	B-UTEA
Wood Duck	*Aix sponsa*	B-WODU
White-winged Scoter	*Melanitta fusca*	B-WWSC

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Vultures, Hawks and Falcons	Order Falconiformes	*Code*
American Kestrel	*Falco sparverius*	B-AMKE
Bald Eagle	*Haliaeetus leucocephalus*	B-BAEA
Broad-winged Hawk	*Buteo platypterus*	B-BWHA
Cooper's Hawk	*Accipiter cooperii*	B-COHA
Eurasian Kestrel	*Falco tinnunculus*	B-EUKE
Ferruginous Hawk	*Buteo regalis*	B-FEHA
Golden Eagle	*Aquila chrysaetos*	B-GOEA
Gyrfalcon	*Falco rusticolus*	B-GYRF
Merlin	*Falco columbarius*	B-MERL
Northern Goshawk	*Accipiter gentilis*	B-NOGO
Northern Harrier	*Circus cyaneus*	B-NOHA
Osprey	*Pandion haliaetus*	B-OSPR
Peregrine Falcon	*Falco peregrinus*	B-PEFA
Prairie Falcon	*Falco mexicanus*	B-PRFA
Rough-legged Hawk	*Buteo lagopus*	B-RLHA
Red-tailed Hawk	*Buteo jamaicensis*	B-RTHA
Sharp-shinned Hawk	*Accipiter striatus*	B-SSHA
Swainson's Hawk	*Buteo swainsoni*	B-SWHA
Turkey Vulture	*Cathartes aura*	B-TUVU
Unspecified Eagle	(unspecified)	B-UEAG
Unspecified Falcon	(unspecified)	B-UFAL
Unspecified Hawk	(unspecified)	B-UHAW
Upland Game Birds	Order Galliformes	
Blue Grouse	*Dendragapus obscurus*	B-BLGR
California Quail	*Callipepla californica*	B-CAQU
Chukar	*Alectoris chukar*	B-CHUK
Gray Partridge	*Perdix perdix*	B-GRPA
Mountain Quail	*Oreortyx pictus*	B-MOQU
Northern Bobwhite	*Colinus virginianus*	B-NOBO
Ring-necked Pheasant	*Phasianus colchicus*	B-RNPH
Rock Ptarmigan	*Lagopus mutus*	B-ROPT
Ruffed Grouse	*Bonasa umbellus*	B-RUGR
Sage Grouse	*Centrocercus urophasianus*	B-SAGR
Spruce Grouse	*Dendragapus canadensis*	B-SPGR
Sharp-tailed Grouse	*Tympanuchus phasianellus*	B-STGR
Willow Ptarmigan	*Lagopus lagopus*	B-WIPT
Wild Turkey	*Meleagris gallopavo*	B-WITU
White-tailed Ptarmigan	*Lagopus leucurus*	B-WTPT
Unspecified Grouse	(unspecified)	B-UGRU
Unspecified Ptarmigan	(unspecified)	B-UPTA
Cranes, Rails and Allies	Order Gruiformes	
American Coot	*Fulica americana*	B-AMCO
Common Moorhen	*Gallinula chloropus*	B-COMO
Sandhill Crane	*Grus canadensis*	B-SACR
Sora	*Porzana carolina*	B-SORA
Virginia Rail	*Rallus limicola*	B-VIRA
Whooping Crane	*Grus americana*	B-WHCR

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Shorebirds, Gulls, Auks and Allies	Order Charadriiformes	*Code*
American Avocet	*Recurvirostra americana*	B-AMAV
Baird's Sandpiper	*Calidris bairdii*	B-BASA
Black-bellied Plover	*Pluvialis squatarola*	B-BBPL
Buff-Breasted Sandpiper	*Tryngites subruficollis*	B-BBSA
Bristle-thighed Curlew	*Numenius tahitiensis*	B-BCTU
Black Oystercatcher	*Haematopus bachmani*	B-BLOY
Black Turnstone	*Arenaria melanocephala*	B-BLTU
Black-necked Stilt	*Himantopus mexicanus*	B-BNST
Bar-tailed Godwit	*Limosa lapponica*	B-BTGO
Common Snipe	*Gallinago gallinago*	B-COSN
Curlew Sandpiper	*Calidris ferruginea*	B-CUSA
Dunlin	*Calidris alpina*	B-DUNL
Greater Yellowlegs	*Tringa melanoleuca*	B-GRYE
Hudsonian Godwit	*Limosa haemastica*	B-HUGO
Killdeer	*Charadrius vociferus*	B-KILL
Long-billed Curlew	*Numenius americanus*	B-LBCU
Long-billed Dowitcher	*Limnodromus scolopaceus*	B-LBDO
Least Sandpiper	*Calidris minutilla*	B-LESA
Lesser Yellowlegs	*Tringa flavipes*	B-LEYE
Lesser Golden-plover	*Pluvialis dominica*	B-LGPL
Marbled Godwit	*Limosa fedoa*	B-MAGO
Pectoral Sandpiper	*Calidris melanotos*	B-PESA
Red Knot	*Calidris canutus*	B-REKN
Red Phalarope	*Phalaropus fulicaria*	B-REPH
Red-necked Phalarope	*Phalaropus lobatus*	B-RNPL
Rufous-necked Stint	*Calidris ruficollis*	B-RNST
Rock Sandpiper	*Calidris ptilocnemis*	B-ROSA
Ruff	*Philomachus pugnax*	B-RUFF
Ruddy Turnstone	*Arenaria interpres*	B-RUTU
Sanderling	*Calidris alba*	B-SAND
Short-billed Dowitcher	*Limnodromus griseus*	B-SBDO
Spoonbill Sandpiper	*Eurynorhynchus pygmeus*	B-SBSA
Spotted Sandpiper	*Actitus macularia*	B-SPSA
Semipalmated Plover	*Charadrius semipalmatus*	B-SEPL
Semipalmated Sandpiper	*Calidris pusilla*	B-SESA
Shorebird	(unspecified)	B-SHOR
Sharp-tailed Sandpiper	*Calidris acuminata*	B-SHSA
Snowy Plover	*Charadrius alexandrinus*	B-SNPL
Solitary Sandpiper	*Tringa solitaria*	B-SOSA
Spotted Redshank	*Tringa erythropus*	B-SPRE
Stilt Sandpiper	*Calidris himantopus*	B-STSA
Surfbird	*Aphriza virgata*	B-SURF
Terek Sandpiper	*Xenus cincereus*	B-XECI
Upland Sandpiper	*Batramia longicauda*	B-UPSA
Wandering Tattler	*Heteroscelus incanus*	B-WATA
Western Sandpiper	*Calidris mauri*	B-WESA
Whimbrel	*Numenius phaeopus*	B-WHIM
Willet	*Catoptrophorus semipalmatus*	B-WILL
Wilson's Phalarope	*Phalaropus tricolor*	B-WIPH
White-rumped Sandpiper	*Calidris fuscicollis*	B-WRSA
Unspecified Shorebird	(unspecified)	B-USHO

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Shorebirds, Gulls, Auks and Allies — Continued	Order Charadriiformes	*Code*
Arctic Tern	*Sterna paradisaea*	B-ARTE
Black-legged Kittiwake	*Rissa tridactyla*	B-BLKI
Black Tern	*Chlidonias niger*	B-BLTE
Bonaparte's Gull	*Larus philadelphia*	B-BOGU
California Gull	*Larus californicus*	B-CAGU
Caspian Tern	*Sterna caspia*	B-CATE
Common Black-tailed Gull	*Larus ridibundus*	B-CBHG
Common Tern	*Sterna hirundo*	B-COTE
Elegant Tern	*Sterna elegans*	B-ELTE
Forster's Tern	*Sterna forsteri*	B-FOTE
Franklin's Gull	*Larus pipixcan*	B-FRGU
Glaucous Gull	*Larus hyperboreus*	B-GLGU
Gull	(unspecified)	B-GULL
Glaucous-winged Gull	*Larus glaucescens*	B-GWGU
Herring Gull	*Larus argentatus*	B-HEGU
Heermann's Gull	*Larus heermanni*	B-HEEG
Iceland Gull	*Larus glaucoides*	B-ICGU
Ivory Gull	*Pagophila eburnea*	B-IVGU
Little Gull	*Larus minutus*	B-LIGU
Long-tailed Jaeger	*Stercorarius longicaudus*	B-LTJA
Mew Gull	*Larus canus*	B-MEGU
Parasitic Jaeger	*Stercorarius parasiticus*	B-PAJA
Pomarine Jaeger	*Stercorarius pomarinus*	B-POJA
Ring-billed Gull	*Larus delawarensis*	B-RBGU
Ross' Gull	*Rhodostethia rosea*	B-ROGU
Sabine's Gull	*Xema sabini*	B-SAGU
Slaty-backed Gull	*Larus schistisagus*	B-SBGU
South Polar Skua	*Catharacta maccormicki*	B-SPSK
Thayer's Gull	*Larus thayeri*	B-THGU
Unspecified Gull	(unspecified)	B-UGUL
Unspecified Tern	(unspecified)	B-UTER
Western Gull	*Larus occidentalis*	B-WEGU
Ancient Murrelet	*Synthliboramphus antiquus*	B-ANMU
Cassin's Auklet	*Ptychoramphus aleuticus*	B-CAAU
Common Murre	*Uria aalge*	B-COMU
Crested Auklet	*Aethia cristatella*	B-CRAU
Horned Puffin	*Fratercula corniculata*	B-HOPU
Marbled Murrelet	*Brachyramphus marmoratus*	B-MAMU
Pigeon Guillemot	*Cepphus columba*	B-PIGU
Rhinoceros Auklet	*Cerorhinca monocerata*	B-RHAU
Thick-billed Murre	*Uria lomvia*	B-TBMU
Tufted Puffin	*Fratercula cirrhata*	B-TUPU
Unspecified Auklet	(unspecified)	B-UAUK
Unspecified Murrelet	(unspecified)	B-UMUL
Unspecified Murre	(unspecified)	B-UMUR
Unspecified Puffin	(unspecified)	B-UPUF
Xantus' Murrelet	*Synthliboramphus hypoleucus*	B-XAMU

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Pigeons and Doves	Order Columbiformes	*Code*
Band-tailed Pigeon	*Columba fasciata*	B-BTPI
Mourning Dove	*Zenaida macroura*	B-MODO
Rock Dove	*Columba livia*	B-RODO
White-winged Dove	*Zenaida asiatica*	B-WWDO
Unspecified Dove	(unspecified)	B-UDOV
Cuckoos	Order Cuculiformes	
Black-billed Cuckoo	*Coccyzus erythropthalmus*	B-BBCU
Yellow-billed Cuckoo	*Coccyzus americanus*	B-YBCU
Owls	Order Strigiformes	
Barred Owl	*Strix varia*	B-BAOW
Boreal Owl	*Aegolius funereus*	B-BOOW
Burrowing Owl	*Athene cunicularia*	B-BUOW
Barn Owl	*Tyto alba*	B-BARO
Flammulated Owl	*Otus flammeolus*	B-FLOW
Great Gray Owl	*Strix nebulosa*	B-GGOW
Great Horned Owl	*Bubo virginianus*	B-GHOW
Long-eared Owl	*Asio otus*	B-LEOW
Northern Hawk Owl	*Surnia ulula*	B-NHOW
Northern Pygmy-Owl	*Glaucidium gnoma*	B-NPOW
Northern Saw-whet Owl	*Aegolius acadicus*	B-NSWO
Short-eared Owl	*Asio flammeus*	B-SEOW
Snowy Owl	*Nyctea scandiaca*	B-SNOW
Spotted Owl	*Strix occidentalis*	B-SPOW
Unspecified Owl	(unspecified)	B-UOWL
Western Screech-Owl	*Otus kennicottii*	B-WSOW
Goatsucker	Order Caprimulgiformes	
Common Nighthawk	*Chordeiles minor*	B-CONI
Common Poorwill	*Phalaenoptilus nuttallii*	B-COPO
Swifts and Hummingbirds	Order Apodiformes	
Anna's Hummingbird	*Calypte anna*	B-ANHU
Black-chinned Hummingbird	*Archilochus alexandri*	B-BCHU
Black Swift	*Cypseloides niger*	B-BLSW
Calliope Hummingbird	*Stellula calliope*	B-CAHU
Costa's Hummingbird	*Calypte costae*	B-COHU
Ruby-throated Hummingbird	*Archilochus colubris*	B-RTHU
Rufous Hummingbird	*Selasphorus rufus*	B-RUHU
Unspecified Hummingbird	(unspecified)	B-UHUM
Unspecified Swift	(unspecified)	B-USWI
Vaux's Swift	*Chaetura vauxi*	B-VASW
White-throated Swift	*Aeronautes saxatalis*	B-WTSW
Kingfishers	Order Coraciiformes	
Belted Kingfisher	*Ceryle alcyon*	B-BEKI

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Woodpeckers	Order Piciformes	*Code*
Black-backed Woodpecker	*Picoides arcticus*	B-BBWO
Downy Woodpecker	*Picoides pubescens*	B-DOWO
Hairy Woodpecker	*Picoides villosus*	B-HAWO
Lewis' Woodpecker	*Melanerpes lewis*	B-LEWO
Northern Flicker	*Colaptes auratus*	B-NOFL
Pileated Woodpecker	*Dryocopus pileatus*	B-PIWO
Red-breasted Sapsucker	*Sphyrapicus ruber*	B-RBSA
Red-headed Woodpecker	*Melanerpes erythrocephalus*	B-RHWO
Red-naped Sapsucker	*Sphyrapicus nuchalis*	B-RNSA
Three-toed Woodpecker	*Picoides tridactylus*	B-TTWO
White-headed Woodpecker	*Picoides albolarvatus*	B-WHWO
Williamson's Sapsucker	*Sphyrapicus thyroideus*	B-WISA
Yellow-bellied Sapsucker	*Sphyrapicus varius*	B-YBSA
Unspecified Woodpecker	(unspecified)	B-UWOO
Passerine Birds	Order Passeriformes	
Acadian Flycatcher	*Empidonax virescens*	B-ACFL
Alder Flycatcher	*Empidonax alnorum*	B-ALFL
Ash-throated Flycatcher	*Myiarchus cinerascens*	B-ATFL
Black Phoebe	*Sayornis nigricans*	B-BLPH
Dusky Flycatcher	*Empidonax oberholseri*	B-DUFL
Eastern Kingbird	*Tyrannus tyrannus*	B-EAKI
Eastern Phoebe	*Sayornis phoebe*	B-EAPH
Gray Flycather	*Empidonax wrightii*	B-GRFL
Gray Kingbird	*Tyrannus dominicensis*	B-GRKI
Hammond's Flycatcher	*Empidonax hammondii*	B-HAFL
Least Flycatcher	*Empidonax minimus*	B-LEFL
Olive-sided Flycatcher	*Contopus borealis*	B-OSFL
Say's Phoebe	*Sayornis saya*	B-SAPH
Scissor-tailed Flycatcher	*Tyrannus forficatus*	B-STFL
Thick-billed Kingbird	*Tyrannus crassirostris*	B-TBKI
Tropical Kingbird	*Tyrannus melancholichus*	B-TRKI
Unspecified Flycatcher	(unspecified)	B-UFLY
Pacific-slope Flycatcher	*Empidonax difficilis*	B-PSFL
Western Kingbird	*Tyrannus verticalis*	B-WEKI
Willow Flycatcher	*Empidonax traillii*	B-WIFL
Western Wood-Pewee	*Contopus sordidulus*	B-WWPE
Yellow-bellied Flycatcher	*Empidonax flaviventris*	B-YBFL
Eurasian Skylark	*Alauda arvensis*	B-EUSK
Horned Lark	*Eremophila alpestris*	B-HOLA
Barn Swallow	*Hirundo rustica*	B-BASW
Bank Swallow	*Riparia riparia*	B-BKSW
Cliff Swallow	*Hirundo pyrrhonota*	B-CLSW
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	B-NRWS
Purple Martin	*Progne subis*	B-PUMA
Tree Swallow	*Tachycineta bicolor*	B-TRSW
Unspecified Swallow	(unspecified)	B-USWA
Violet-green Swallow	*Tachycineta thalassina*	B-VGSW
American Crow	*Corvus brachyrhynchos*	B-AMCR
Black-billed Magpie	*Pica pica*	B-BBMA
Blue Jay	*Cyanocitta cristata*	B-BLJA
Clark's Nutcracker	*Nucifraga columbiana*	B-CLNU
Common Raven	*Corvus corax*	B-CORA
Gray Jay	*Perisoreus canadensis*	B-GRJA

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Passerine Birds — Continued	Order Passeriformes	*Code*
Northwestern Crow	*Corvus caurinus*	B-NOCR
Scrub Jay	*Aphelocoma coerulescens*	B-SCJA
Steller's Jay	*Cyanocitta stelleri*	B-STJA
Black-capped Chickadee	*Parus atricapillus*	B-BCCH
Boreal Chickadee	*Parus hudsonicus*	B-BOCH
Bushtit	*Psaltriparus minimus*	B-BUSH
Chestnut-backed Chickadee	*Parus rufescens*	B-CBCH
Mountain Chickadee	*Parus gambeli*	B-MOCH
Unspecified Chickadee	(unspecified)	B-UCHI
Pygmy Nuthatch	*Sitta pygmaea*	B-PYNU
Red-breasted Nuthatch	*Sitta canadensis*	B-RBNU
Unspecified Nuthatch	(unspecified)	B-UNUT
White-breasted Nuthatch	*Sitta carolinensis*	B-WBNU
Bewick's Wren	*Thryomanes bewickii*	B-BEWR
Brown Creeper	*Certhia americana*	B-BRCR
Canyon Wren	*Catherpes mexicanus*	B-CAWR
House Wren	*Troglodytes aedon*	B-HOWR
Marsh Wren	*Cistothorus palustris*	B-MAWR
Rock Wren	*Salpinctes obsoletus*	B-ROWR
Unspecified Wren	(unspecified)	B-UWRE
Winter Wren	*Troglodytes troglodytes*	B-WIWR
American Dipper	*Cinclus mexicanus*	B-AMDI
American Robin	*Turdus migratorius*	B-AMRO
Blue-gray Gnatcatcher	*Polioptila caerulea*	B-BGGN
Golden-crowned Kinglet	*Regulus satrapa*	B-GCKI
Gray-cheeked Thrush	*Catharus minimus*	B-GCTH
Hermit Thrush	*Catharus guttatus*	B-HETH
Mountain Bluebird	*Sialia currucoides*	B-MOBL
Northern Wheatear	*Oenanthe oenanthe*	B-NOWH
Ruby-crowned Kinglet	*Regulus calendula*	B-RCKI
Swainson's Thrush	*Catharus ustulatus*	B-SWTH
Townsend's Solitaire	*Myadestes townsendi*	B-TOSO
Unspecified Bluebird	(unspecified)	B-UBLU
Unspecified Kinglet	(unspecified)	B-UKIN
Unspecified Thrush	(unspecified)	B-UTHR
Varied Thrush	*Ixoreus naevius*	B-VATH
Veery	*Catharus fuscescens*	B-VEER
Western Bluebird	*Sialia mexicana*	B-WEBL
Brown Thrasher	*Toxostoma rufum*	B-BRTH
Gray Catbird	*Dumetella carolinensis*	B-GRCA
Northern Mockingbird	*Mimus polyglottos*	B-NOMO
Sage Thrasher	*Oreoscoptes montanus*	B-SATH
Black-backed Wagtail	*Motacilla lugens*	B-BBWG
Bohemian Waxwing	*Bombycilla garrulus*	B-BOWA
Cedar Waxwing	*Bombycilla cedrorum*	B-CEWA
Crested Myna	*Acridotheres cristatellus*	B-CRMY
European Starling	*Sturnus vulgaris*	B-EUST
Hutton's Vireo	*Vireo huttoni*	B-HUVI
Loggerhead Shrike	*Lanius ludovicianus*	B-LOSH
Northern Shrike	*Lanius excubitor*	B-NOSH
Philadelphia Vireo	*Vireo philadelphicus*	B-PHVI
Red-eyed Vireo	*Vireo olivaceus*	B-REVI
Solitary Vireo	*Vireo solitarius*	B-SOVI

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Passerine Birds — Continued	Order Passeriformes	*Code*
Unspecified Shrike	(unspecified)	B-USHI
Unspecified Vireo	(unspecified)	B-UVIR
Unspecified Waxwing	(unspecified)	B-UWAX
Water Pipit	*Anthus spinoletta*	B-WAPI
Warbling Vireo	*Vireo gilvus*	B-WAVI
American Redstart	*Setophaga ruticilla*	B-AMRE
American Tree Sparrow	*Spizella arborea*	B-ATSP
Black-and-white Warbler	*Mniotilta varia*	B-BAWW
Bay-breasted Warbler	*Dendroica castanea*	B-BBWA
Black-headed Grosbeak	*Pheucticus melanocephalus*	B-BHGR
Blackburnian Warbler	*Dendroica fusca*	B-BLWA
Blackpoll Warbler	*Dendroica striata*	B-BPWA
Brewer's Sparrow	*Spizella breweri*	B-BRSP
Black-throated Blue Warbler	*Dendroica caerulescens*	B-BTBW
Black-throated Gray Warbler	*Dendroica nigrescens*	B-BTGW
Black-throated Green Warbler	*Dendroica virens*	B-BTNW
Black-throated Sparrow	*Amphispiza bilineata*	B-BTSP
Canada Warbler	*Wilsonia canadensis*	B-CAWA
Clay-colored Sparrow	*Spizella pallida*	B-CCSP
Chipping Sparrow	*Spizella passerina*	B-CHSP
Cape May Warbler	*Dendroica tigrina*	B-CMWA
Connecticut Warbler	*Oporornis agilis*	B-COWA
Common Yellowthroat	*Geothlypis trichas*	B-COYE
Chestnut-sided Warbler	*Dendroica pensylvanica*	B-CSWA
Dickcissel	*Spiza americana*	B-DICK
Grasshopper Sparrow	*Ammodramus savannarum*	B-GRSP
Indigo Bunting	*Passerina cyanea*	B-INBU
Lark Bunting	*Calamospiza melanocorys*	B-LABU
Lark Sparrow	*Chondestes grammacus*	B-LASP
Le Conte's Sparrow	*Ammodramus leconteii*	B-LCSP
Lazuli Bunting	*Passerina amoena*	B-LZBU
Magnolia Warbler	*Dendroica magnolia*	B-MAWA
MacGillivray's Warbler	*Oporornis tolmiei*	B-MGWA
Mourning Warbler	*Oporornis philadelphia*	B-MOWA
Nashville Warbler	*Vermivora ruficapilla*	B-NAWA
Northern Waterthrush	*Seiurus noveboracensis*	B-NOWA
Orange-crowned Warbler	*Vermivora celata*	B-OCWA
Ovenbird	*Seiurus aurocapillus*	B-OVEN
Painted Redstart	*Myioborus pictus*	B-PARE
Palm Warbler	*Dendroica palmarum*	B-PAWA
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	B-RBGR
Rufous-sided Towhee	*Pipilo erythrophthalmus*	B-RSTO
Sage Sparrow	*Amphispiza belli*	B-SASP
Savannah Sparrow	*Passerculus sandwichensis*	B-SAVS
Scarlet Tanager	*Piranga olivacea*	B-SCTA
Tennessee Warbler	*Vermivora peregrina*	B-TEWA
Townsend's Warbler	*Dendroica townsendi*	B-TOWA
Unspecified Sparrow	(unspecified)	B-USPA
Unspecified Warbler	(unspecified)	B-UWAR
Vesper Sparrow	*Pooecetes gramineus*	B-VESP
Western Tanager	*Piranga ludoviciana*	B-WETA
Wilson's Warbler	*Wilsonia pusilla*	B-WIWA
Yellow-breasted Chat	*Icteria virens*	B-YBCH

Table 6.5 Animal and bird species codes (after Cannings and Harcombe, 1990) — *Continued*

Passerine Birds — Continued	Order Passeriformes	*Code*
Yellow Warbler	*Dendroica petechia*	B-YEWA
Yellow-rumped Warbler	*Dendroica coronata*	B-YRWA
Brown-headed Cowbird	*Molothrus ater*	B-BHCO
Bobolink	*Dolichonyx oryzivorus*	B-BOBO
Brewer's Blackbird	*Euphagus cyanocephalus*	B-BRBL
Chestnut-collared Longspur	*Calcarius ornatus*	B-CCLO
Common Grackle	*Quiscalus quiscula*	B-COGR
Dark-eyed Junco	*Junco hyemalis*	B-DEJU
Fox Sparrow	*Passerella iliaca*	B-FOSP
Golden-crowned Sparrow	*Zonotrichia atricapilla*	B-GCSP
Great-tailed Grackle	*Quiscalus mexicanus*	B-GTGR
Harris' Sparrow	*Zonotrichia querula*	B-HASP
House Sparrow	*Passer domesticus*	B-HOSP
Lapland Longspur	*Calcarius lapponicus*	B-LALO
Lincoln's Sparrow	*Melospiza lincolnii*	B-LISP
McKay's Bunting	*Plectrophenax hyperboreus*	B-MCBU
McCown's Longspur	*Calcarius mccownii*	B-MCLO
Northern Oriole	*Icterus galbula*	B-NOOR
Rusty Blackbird	*Euphagus carolinus*	B-RUBL
Rustic Bunting	*Emberiza rustica*	B-RUBU
Red-winged Blackbird	*Agelaius phoeniceus*	B-RWBL
Smith's Longspur	*Calcarius pictus*	B-SMLO
Snow Bunting	*Plectrophenax nivalis*	B-SNBU
Song Sparrow	*Melospiza melodia*	B-SOSP
Sharp-tailed Sparrow	*Ammodramus caudacutus*	B-STSP
Swamp Sparrow	*Melospiza georgiana*	B-SWSP
Unspecified Blackbird	(unspecified)	B-UBLA
Unspecified Longspur	(unspecified)	B-ULON
Unspecified Sparrow	(unspecified)	B-USPA
White-crowned Sparrow	*Zonotrichia leucophrys*	B-WCSP
Western Meadowlark	*Sturnella neglecta*	B-WEME
White-throated Sparrow	*Zonotrichia albicollis*	B-WTSP
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	B-YHBL
American Goldfinch	*Carduelis tristis*	B-AMGO
Brambling	*Fringilla montifringilla*	B-BRAM
Cassin's Finch	*Carpodacus cassinii*	B-CAFI
Common Redpoll	*Carduelis flammea*	B-CORE
Evening Grosbeak	*Coccothraustes vespertinus*	B-EVGR
House Finch	*Carpodacus mexicanus*	B-HOFI
Hoary Redpoll	*Carduelis hornemanni*	B-HORE
Lesser Goldfinch	*Carduelis psaltria*	B-LEGO
Pine Grosbeak	*Pinicola enucleator*	B-PIGR
Pine Siskin	*Carduelis pinus*	B-PISI
Purple Finch	*Carpodacus purpureus*	B-PUFI
Red Crossbill	*Loxia curvirostra*	B-RECR
Rosy Finch	*Leucosticte arctoa*	B-ROFI
Unspecified Crossbill	(unspecified)	B-UCRO
Unspecified Finch	(unspecified)	B-UFIN
Unspecified Grossbeak	(unspecified)	B-UGRO
Unspecified Redpoll	(unspecified)	B-URED
White-winged Crossbill	*Loxia leucoptera*	B-WWCR

CHAPTER 7

HUMUS FORM DESCRIPTION

HUMUS FORM AND ORGANIC SOIL DESCRIPTION

(B.C. Ministry of Forests, 1981)

Form Number ☐☐☐☐☐☐☐☐

Project I.D.

Plot No.

Surveyor ____________ Page ___ of ___

Taxon

1	2	3	4		5		6	7		8	9	10	11	12			13	14	15							
HORIZON							MOIST STAT	COLOUR		FABRIC			TEXTURE	MATERIAL COMPOSIT.			PYRO INDEX	VON POST SCALE	ROOTS 1				ROOTS 2			
Desig.	Lab No.	Depth	Thickness Min.	Thickness Max.	Boundary Distr.	Boundary Form		Aspect	Munsell not.	Structure	Consistence	Character		Kind 1	Kind 2	Decom			Ab.	Size	Orig.	Distr.	Ab.	Size	Orig.	Distr.

1	16				17								18	19	20
Horizon Desig	NON-CONFORMING MATERIALS				SOIL BIOTA								pH	BULK DENSITY	Schematic Humus Form Profile
					Flora			Fauna							
	Kind	Distr.	Size	Ab.	Kind	Distr.	Ab.	Kind	Size	Ab.	Droppings Dist	Droppings Ab			

SOIL TEMP. cm	°C
0	
10	
50	
100	

NOTES ____________

Chapter Seven

HUMUS FORM DESCRIPTION

INTRODUCTION

The Humus Form Description provides the opportunity for more detailed description and classification of humus forms than is possible on the Soil Description Form. The humus form classification and characterization follows that of Klinka *et al.* (1981) and is applicable to organic accumulations associated with both mineral and organic soils.

Procedures are not yet developed for direct key entry of the Humus Form Description into computer data banks, thus field coding of the form is not as precise as that on the other field forms.

The form number, taken from the Site Description Form, is entered into the box in the upper right-hand corner. Project I.D. and Plot No. are also from the Site Description Form and are entered in the appropriate places. Surveyor is the name of the individual coding the Humus Form Description.

Humus forms are described on the basis of horizons (or layers) according to Klinka *et al.* (1981). When examining humus forms, all distinguishable horizons and layers are described separately. Properties described need not be applicable to each horizon or layer and may not be taxonomic differentiae. However, complete description of the morphological properties is recommended. Morphological properties are visually determined in the field (supplemented by a 10X or 20X hand lens). A binocular microscope is often used for more detailed examinations in the laboratory.

When describing a humus form, determine the boundaries of the control section, decide about the limits of the humus form profile, locate the boundaries between horizons, and examine the profile in total before naming and describing the individual horizons. Sampling for physical and chemical analysis of individual horizons or horizon combinations (composite samples) should be carried out as required.

TAXON

Enter the appropriate humus form group or subgroup code as determined from Table 7.1. If this information is to be also entered on the Site Description Form (e.g., for the purposes of BCSIS computer use), use the following procedures. Under "Soil Phase" (Item 17) on the Site Description Form, beginning with column 38 in the free format area, enter "H81;" in the first four spaces. Enter the subgroup adjective in the fifth space, and in the sixth to eighth spaces enter the group symbol (left justified). The decimal is not entered. If only the order code is entered, place it in the eighth space. For example, H 8 1 ; O W R identifies the Orthivelomor subgroup and H 8 1 ; _ H U R identifies the Hemihumimor group (subgroup unknown).

A summary of the humus form classification system by Klinka *et al.* (1981) follows.

Introduction

The objective of the taxonomic classification is to develop a hierarchy of classes that permit an understanding of the natural relationships between humus forms, and of the factors involved in their formation. The differentiae for the classes are properties that are either observable in the field or can be inferred from observed properties.

Taxa are provided for all humus forms currently known to occur in British Columbia (and in other places under the influence of comparable climates). Effort has been made to explicitly define each taxon and to identify meaningful and useful class boundaries.

Table 7.1 presents a synopsis of the three-category taxonomic classification. In order of decreasing categorical rank and increasing number of differentiae, the categories are humus form "order", "group", and "subgroup".

Table 7.1 A synopsis of humus form taxa with codes (after Klinka *et al.*, 1981)

Order	Group	Subgroup*	Code
Mor (R)	Velomor (WR)	Orthivelomor	O.WR
		Neovelomor	Q.WR
		Amphivelomor	A.WR
	Xeromor (XR)	Orthixeromor	O.XR
		Lignoxeromor	L.XR
		Amphixeromor	A.XR
	Hemimor (HR)	Orthihemimor	O.HR
		Mycohemimor	M.HR
		Lignohemimor	L.HR
		Amphihemimor	A.HR
	Hemihumimor (HUR)	Orthihemihumimor	O.HUR
		Mycohemihumimor	M.HUR
		Lignohemihumimor	L.HUR
		Granulohemihumimor	G.HUR
		Residuohemihumimor	R.HUR
		Amphihemihumimor	A.HUR
	Humimor (UR)	Orthihumimor	O.UR
		Mycohumimor	M.UR
		Lignohumimor	L.UR
		Granulohumimor	G.UR
		Residuohumimor	R.UR
		Amphihumimor	A.UR
	Hydromor (YR)	Orthihydromor	O.YR
		Residuohydromor	R.YR
		Hemihydromor	H.YR
		Saprihydromor	S.YR
	Histomor (IR)	Orthihistomor	O.IR
		Fermihistomor	F.IR
		Saprihistomor	S.IR
		Hydrohistomor	H.IR
Moder (D)	Velomoder (WD)	Orthivelomoder	O.WD
		Minerovelomoder	M.WD
		Amphivelomoder	A.WD
	Xeromoder (XD)	Orthixeromoder	O.XD
		Mineroxeromoder	M.XD
		Amphixeromoder	A.XD
	Mormoder (RD)	Orthimormoder	O.RD
		Humimormoder	U.RD
		Mineromormoder	M.RD
		Amphimormoder	A.RD
	Leptomoder (TD)	Orthileptomoder	O.TD
		Hemileptomoder	H.TD
		Mineroleptomoder	M.TD
		Amphileptomoder	A.TD
	Mullmoder (LD)	Orthimullmoder	O.LD
		Vermimullmoder	V.LD
		Rhizomullmoder	Z.LD
	Hydromoder (YD)	Orthihydromoder	O.YD
		Ectohydromoder	E.YD
		Saprihydromoder	S.YD
	Histomoder (ID)	Orthihistomoder	O.ID
		Fibrihistomoder	B.ID
		Saprihistomoder	S.ID
		Hydrohistomoder	H.ID
Mull (L)	Rhizomull (ZL)	Orthirhizomull	O.ZL
		Crustorhizomull	C.ZL
		Vermirhizomull	V.ZL
		Xerorhizomull	X.ZL
	Vermimull (VL)	Orthivermimull	O.VL
		Microvermimull	J.VL
		Macrovermimull	K.VL
	Hydromull (YL)	Orthihydromull	O.YL
		Humihydromull	U.YL
		Saprihydromull	S.YL
	Saprimull (SL)	Orthisaprimull	O.SL
		Parasaprimull	P.SL
		Histosaprimull	I.SL
		Humisaprimull	U.SL
		Hydrosaprimull	Y.SL

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* Intergrade subgroups may also be recognized (i.e., Myco-Lignohumimor is coded as ML.UR).

Categories

The taxonomic differentiae for orders and groups are based on the presence or absence of diagnostic organic and mineral horizons, relative thickness of these horizons, and features that indicate the humus-forming processes. Orders are differentiated by horizon combinations including the kind of F horizon that is present.

The differentiae for groups emphasize genetic homogeneity. They are based, in general, on segregation along the soil moisture gradient into xeromorphic, mesomorphic, and hydromorphic humus forms, and according to kind and arrangement of horizons.

The subgroups agglomerate humus forms that have close similarities in kind and fabric of materials and horizon sequence. Three kinds of subgroups are identified:

1. subgroups that conform to the central concept of the group;
2. subgroups that deviate from the central concept by having aberrant, apparently genetically subordinate features; and,
3. subgroups having properties intergrading to other subgroups or groups.

Phases provide flexibility in the system by considering properties other than those that differentiate taxa. Phases may be recognized for subgroups, groups, and orders.

Nomenclature

Nomenclature in the classification follows the principles applied by USDA Soil Survey Staff (1975a). The name of each taxon indicates its position in the classification, as well as its class in all categories of which it is a member. Formative elements used in the nomenclature suggest prominent properties, preferably those used as taxonomic differentiae.

The three internationally accepted terms — **Mor, Moder, Mull** — form the taxa at the order level. Groups are named by adding a formative element to the name of the order while names of subgroups are formed by adding a formative element to the name of the group. "Orthi" defines the subgroup that represents the central concept of the group. Each "orthi" subgroup exhibits a clear expression of all diagnostic properties of the order and group to which it belongs; therefore, "orthi" subgroups have properties neither transitional to other subgroups, nor aberrant properties that require special recognition. Other formative elements designate the subgroups that have, in addition to the properties of their group, some aberrant properties requiring special recognition. The subgroups in Table 7.1 are not the only possible subgroups in the classification. Intergrade subgroups may be recognized, i.e., those having properties of another subgroup in the same group. They are named by prefixing the two formative elements of the subgroups to the group name. Thus, a Lignohumimor containing abundant fungal mycelia is named a Myco-Lignohumimor. An illustration of the nomenclature as it relates to the different categories in the system follows:

Mor	Order
Hemimor	Group
Orthihemimor	Subgroup

The taxonomic class of a specific humus form can be determined by following the keys in Tables 7.2 to 7.5 and by referring to the list of group and subgroup names in Tables 7.6 and 7.7, respectively. Subsequent consultation of the taxon definition in Klinka *et al.* (1981) is beneficial as well.

Names of phases consist of one or more modified Latin or Greek adjective preceding a subgroup, group or order name (Table 7.8). For example, Humimors with high bulk densities are named Compactic Humimors.

Adjectives used as formative elements in naming groups and subgroups can be also used for phasing. Thus, the term "Lignic Mor phase" refers to all Mors which contain a high amount of decaying wood. To use "lignic" in this way is equivalent to creating an informal group (taxon). Adjectives in names of phases are arranged according to interpretative significance. Redundancy in names of subgroup phases should be avoided. If a property is specified for a subgroup, which may or may not be used in its name, it should not be used in a phase name. The first letter is capitalized in the names of all taxa and their phases.

Table 7.2 Key to humus form orders (after Klinka, *et al.*, 1981)

- 1a. Well aerated, terrestrial humus forms that can be temporarily saturated (xeric to hygric moisture regimes)
  - 2a. Ectorganic horizons are predominant in the humus form profile; both F and H horizons are each >1 cm thick
    - 3a. F horizons are predominantly mycogenous (Fq) .... **Mor**
    - 3b. F horizons are predominantly zoogenous (Fa) or zoogenous-mycogenous (Faq) .... **Moder**
  - 2b. Ectorganic horizons are very thin and insignificant in the humus form profile; both F and H horizons are each <1 cm thick; well-developed rhizogenous or zoogenous Ah horizons are >2 cm thick .... **Mull**
- 1b. Poorly aerated, terrestrial to semi-terrestrial humus forms influenced by prolonged or permanent saturation (hygric to subhygric moisture regimes)
  - 4a. O horizons comprise >50% of the thickness of organic horizons in the humus form profile
    - 5a. Of horizons are dominant in the humus form profile .... **Mor**
    - 5b. Om horizons are dominant in the humus form profile .... **Moder**
    - 5c. Oh or Ohi horizons are dominant in the humus form profile .... **Mull**
  - 4b. O horizons comprise <50% of the thickness of organic horizons in the humus form profile
    - 6a. Ectorganic horizons generally >2 cm in thickness are significant in the humus form profile
      - 7a. Fq horizon present; Ah or Ahg horizons are absent or <5 cm thick .... **Mor**
      - 7b. Fa horizon is present; Ah or Ahg horizons are >5 cm thick .... **Moder**
    - 6b. Ectorganic horizons are very thin and insignificant in the humus form profile (generally <2 cm thick). Well developed Ahg or Ah horizons >5 cm thick dominate the profile **Mull**

ectorganic — organic (L, F, H, O) horizons in humus form profile
endorganic — mineral (Ah) horizon in humus form profile

Table 7.3 Key to groups of the Mor order (after Klinka *et al.*, 1981)

- 1a. Well-aerated Mors that can be temporarily saturated by water
  - 2a. L horizons comprise >80% of the thickness of ectorganic horizons .... **Velomor**
  - 2b. L horizons comprise <80% of the thickness of ectorganic horizons
    - 3a. Prolonged moisture deficiency in the growing season (xeric moisture regimes) **Xeromor**
    - 3b. None or short term moisture deficiency
      - 4a. H horizon comprises <30% of the combined thickness of Fq and H horizons .... **Hemimor**
      - 4b. H horizon comprises >30% of the combined thickness of Fq and H horizons
        - 5a. H horizon comprises >30% but <70% of the combined thickness of Fq and H horizons .... **Hemihumimor**
        - 5b. H horizon comprises >70% of the combined thickness of Fq and H horizons .... **Humimor**
- 1b. Poorly aerated Mors; prolonged or permanent saturation by water (hygric to subhydric moisture regimes)
  - 6a. Fq and/or H horizons comprise >50% of the thickness of organic horizons in the humus form profile; endorganic horizons are lacking .... **Hydromor**
  - 6b. 0 horizons comprise >50% of the thickness of organic horizons in the humus form profile; Of horizons comprise >50% of the combined thickness of the 0 horizons **Histomor**

Table 7.4 Key to groups of the Moder order (after Klinka *et al.*, 1981)

- 1a. Well aerated Moders that may be temporarily saturated by water
  - 2a. L horizons comprise >80% of the total thickness of ectorganic horizons. Thin Fa horizons are always present .... **Velomoder**
  - 2b. L horizons comprise <80% of the total thickness of ectorganic horizons. Fa or Faq horizons always present
    - 3a. Prolonged moisture deficiency during the growing season (xeric moisture regimes) .... **Xeromoder**
    - 3b. None or short term moisture deficiency
      - 4a. Fa horizons are present in the humus form profile
        - 5a. Total thickness of endorganic horizons is greater than the total thickness of ectorganic horizons horizons (excluding L) .... **Mullmoder**
        - 5b. Total thickness of endorganic horizons is less than the thickness of ectorganic horizons (excluding L) .... **Leptomoder**
      - 4b. Faq horizons are present in the humus form profile; Fa horizons are minor or absent .... **Mormoder**
- 1b. Poorly aerated Moders; prolonge[illegible] permanent saturation by water (hygric to subhydric moisture regimes)
  - 6a. F horizons and/or H horizons comprise >50% of the thickness of organic horizons in the humus form profile; Ah or Ahg horizons >5 cm thick are present .... **Hydromoder**
  - 6b. (Of), Om (and Oh) horizons comprise >50% of the thickness of organic horizons in the humus form profile. Om horizons comprise >50% of the combined thickness of the O horizons .... **Histomoder**

Table 7.5 Key to groups of the Mull order (after Klinka *et al.*, 1981)

- 1a. Well-aerated Mulls that may be temporarily saturated by water; Ah horizons >2 cm thick are always present; F horizon is <1 cm thick
  - 2a. Rhizogenous Ah horizons developed from decomposition of dense networks of fine roots of herbaceous vegetation, creating a sod; structure is generally blocky .... **Rhizomull**
  - 2b. Zoogenous Ah horizons developed primarily by active populations of earthworms; structure is always granular .... **Vermimull**
- 1b. Poorly aerated Mulls; prolonged or permanent saturation by water (hygric to subhydric moisture regimes)
  - 3a. Humus form profile is dominated by Ah(g) horizons; F horizons are always <1 cm thick. Oh horizons, if present, are less than the thickness of the Ah(g) .... **Hydromull**
  - 3b. Humus form profile is dominated by Oh horizons; the combined thickness of F, Of, Om, and Ah horizons is always less than the thickness of the Oh horizons .... **Saprimull**

Table 7.6 Formative elements of group names (after Klinka, *et al.*, 1981)

Hemi	Designates terrestrial Mors that have prominent F horizons
Histo	Mors and Moders that feature well developed Of or Om horizons
Humi	Designates terrestrial Mors that have a prominent H horizon
Hydro	Humus forms formed under the influence of hygric to subhydric soil moisture regimes
Lepto	Refers to small droppings, dropping residues and exoskeletons of soil mesofauna characteristic of the Fa horizon; used to designate the representative group of Moders
Mor	Implying properties of Mors
Mull	Implying properties of Mulls
Rhizo	Refers to the rhizogenous Ah horizon in Mulls formed from the decomposition of roots of herbaceous plants, mainly grasses
Sapri	Semi-terrestrial Mulls with an Oh horizon formed under the influence of a subhydric or hydric soil moisture regime
Velo	Thin ectorganic horizons dominated by litter materials
Vermi	Refers to the zoogenous Ah horizon in Mulls; earthworms (Lumbricidae) are the representative soil fauna
Xero	Implying a xeric soil moisture regime; xeric may be used as the more general class that includes very xeric, xeric and subxeric classes of the moisture regime

Table 7.7 Formative elements of subgroup names (after Klinka *et al.*, 1981)

Amphi	Mors and Moders with well-developed endorganic horizons
Crusto	Rhizomulls with dry, brittle, and firm fabric in the upper portion of the humus form profile
Ecto	Hydromoders lacking Ah horizons
Fermi	Histomors with a well-developed Om horizon
Fibri	Histomoders with a well-developed Of horizon
Granulo	Mors with a friable, moderately to strongly granular H horizon
Hemi	Hydromors and Leptomoders with a well-developed F horizon
Histo	Saprimulls with a well-developed Of or Om horizon
Humi	Mors that have a prominent H horizon
Hydro	designates intergrade subgroups of all orders formed in a semi-terrestrial environment (hygric to hydric soil moisture regimes)
Ligno	Mors containing >50% decaying wood by volume
Macro	Vermimulls with moderate to strong, medium to coarse granular structure
Micro	Vermimulls with moderate to strong, fine, granular structure
Minero	Xeromoders, Mormoders, and Leptomoders containing significant amounts of intermixed mineral particles, as indicated by Faι, Hdι, or Hdaι horizons
Myco	Mors with a horizon comprised almost entirely of fungal mycelia
Neo	Velomors that consist entirely of litter materials
Orthi	subgroup that typifies the central concept of the group
Para	Saprimulls that lack Ohι or Ahg horizons
Residuo	Mors in which an Hr horizon, characterized by the presence of fine plant (mainly root) residues, is dominant in the humus form profile
Rhizo	Mullmoders with rhizogenous (rooty) Ah horizons
Sapri	Hydromors, Histomors, Hydromoders, Histomoders, and Hydromulls, with well-developed Oh horizons
Vermi	Rhizomulls with a zoogenous Ah horizon
Xero	Rhizomulls formed in semi-arid (to subhumid) climates under a xeric (very xeric, xeric or subxeric) moisture regime

Table 7.8 Humus form phases (after Klinka *et al.*, 1981)

Phase[1]	*Connotation*
Acidic	acid; humus forms with high acidity.
Aeric	air; humus forms with low bulk densities (high porosity).
Albic	white; humus forms underlain by a well-developed Ae horizon.
Charcic	charcoal; humus forms that contain >20% by volume of charcoal.
Clastic	humus forms that contain >20% by volume of coarse fragments.
Compactic	concentrated; humus forms with high bulk densities (low porosity).
Crustic	crisp; humus forms whose upper horizons have a dry, brittle, and firm fabric.
Dystrophic	infertile; humus forms that are nutrient deficient.
Eutrophic	fertile; humus forms that are nutrient rich.
Hygric	wet; humus forms influenced by subsurface water flow.
Lignic	wood; humus forms that contain >50% by volume of decaying wood.
Ochric	pale; humus forms that have Ah horizons with moist colour values ≥3.
Pachic	thick humus forms.
Pellic	dusky; humus forms that have Ah horizons with moist colour values <3 and low chroma.
Rhodic	rose; Mor humus forms that have a prominently reddish coloured Hr horizon, usually derived from decaying wood materials.
Ruptic	broken; humus forms with disrupted horizon(s).
Spodic	wood ash; humus forms with well-developed podzolic horizons, high in organic matter content, directly underlying ectorganic horizons.
Tenuic	thin humus forms.
Terric	earth; humus forms with a mineral horizon in the humus form profile.
Turbic	humus forms that have truncated profiles or have been markedly disrupted by physical processes.
Ustic	burnt; humus forms that have been recently affected by fire and feature a black, crusty (hard, brittle, and tenacious) surface horizon.

[1] These phases indicate non-conformity in properties relative to the concept of a formal taxon. The list is not exhaustive and others can be defined as required.

1-5. HORIZON

1. Designation (Desig.)

Master horizons are similar to those of the Expert Committee on Soil Survey (1987) and are defined as follows:

L — a terrestrial master organic horizon consisting of relatively fresh organic residues in which virtually entire original structures are discernible. May be discoloured and show some signs of biotic activity, but is not substantially comminuted and does not show macroscopically obvious signs of decomposition.

F — a terrestrial master organic horizon characterized by more-or-less disintegrated plant residues in which partial (rather than entire), macroscopically discernible vegetative structures are dominant.

H — a terrestrial master organic horizon dominated by fine substances in which the original structures are macroscopically indiscernible.

O — a semi-terrestrial or wetland master organic horizon.

A — a terrestrial master mineral horizon containing 17% or less organic carbon (about 30% organic matter) by weight. It is formed at or near the soil surface either in the zone of leaching (eluviation) of materials in solution or suspension, or in the zone of maximum *in situ* accumulation of organic matter, or both.

Lower case suffixes identify variations in the range of master horizons and are defined below. Laboratory analyses may be needed for definitive identification of some master horizons and lowercase suffixes.

Lo — an L horizon composed of newly accreted organic materials. These materials are usually loose, exhibit no structural changes, may be slightly discoloured, and are found on the ground surface, particularly during and after the growing season.

Lv — an L horizon composed of less recently accreted organic materials. Some abiological disintegration and strong discoloration is usually apparent.

Fq — an F horizon that is composed primarily of macroscopically recognizable, structurally well-preserved plant residues. The materials have a matted or banded fabric interwoven by abundant fungal hyphae. Faunal droppings or dropping residues are either absent or present only in small amounts.

Fa — an F horizon composed primarily of macroscopically recognizable plant residues which have been partly fragmented or comminuted by soil fauna. The materials are loose, not matted; fungal hyphae may be present in small amounts. Faunal droppings and dropping residues are numerous and can be easily observed under magnification.

Faq — an intergrade F horizon containing both abundant fungal hyphae and numerous faunal droppings. The abundance of droppings and dropping residues increases in the lower part of the F horizon.

Hd — an H horizon in which fine organic substances predominate and very few plant residues are evident. The colour is usually dark grayish brown or black.

Hda — an H horizon in which fine organic substances predominate. Droppings resulting from active populations of soil fauna constitute almost the entire fabric.

Hr — an H horizon in which macroscopically recognizable plant residues of fine roots, wood, and bark (rarely foliage) are present but do not predominate over fine substances. Yellow, brown, and particularly red colours (or their combinations) often prevail.

Of — an O horizon consisting largely of fibric materials whose botanical origin is readily identifiable. It has 40% or more rubbed fibre by volume and a pyrophosphate index of 5 or more. Rubbed fibre is that which remains after a sample is rubbed about 10 times between thumb and forefinger. Fibric materials are in classes 1 to 4 of the von Post scale of decomposition.

Om — an O horizon consisting of mesic (partly decomposed) materials which are at a stage of decomposition intermediate between fibric and humic. The mesic material is partly altered both physically and biochemically and is usually in class 5 or 6 of the von Post scale of decomposition. The Om horizon does not meet the definition of either an Of or Oh horizon.

Oh — an O horizon in which the original organic material has been well decomposed (humified). The rubbed fibre content is less than 10% by volume and the pyrophosphate index is 3 or less. Humic materials are usually in classes 7 to 10 of the von Post decomposition scale.

Ah — an A horizon enriched with organic matter. It has a colour value at least one unit lower than the underlying horizon or 0.5% more organic carbon than the C horizon or both. It contains less than 17% organic carbon by weight.

Greek letters used as lowercase suffixes are not restricted to any particular horizon or layer in the humus form profile. They are defined as follows:

β — (beta) a horizon in which the organic material is predominantly (>50% volume) or entirely charcoal. The suffix is applied to F, H, and O master organic horizons either alone (e.g., Fβ) to indicate a "charcoal horizon", or with other suffixes (e.g., Fqβ) to indicate a predominance of charcoal.

ι — (iota) a horizon in which the organic materials contain intermixed mineral particles finer than 2 mm. Organic carbon by weight is more than 17% but less than 35%. The suffix is applied to L, F, H, and O organic horizons (e.g., Hι). The intermixing may result from several different processes (or their combination). The process should be indicated in the description using the following terms: colluvial, eolian, alluvial, cryoturbation, silvoturbation, and/or zoological.

θ — (theta) an organic horizon comprised almost entirely of fungal mycelia. The colour is generally light gray and the consistence and character are resilient and felty, respectively. It is most often applied to Fq horizons since partially decomposed plant residues are usually incorporated.

λ — (lambda) an organic horizon or layer in which the organic material is predominantly (>50% by volume) wood in various stages of decomposition. The suffix is applied to L, F, H, and O master organic horizons (e.g., Ofλ) to indicate a predominance of decaying wood, or used with L, F, and H alone to indicate a "decaying wood horizon" (i.e., Lλ, Fλ, Hλ).

σ — (sigma) an organic horizon consisting of fine (colloidal) organic materials accumulated by sedimentation. The suffix is used with H and O master organic horizons (i.e., Hσ, Oσ).

Table 7.9 demonstrates how lowercase suffixes should be used and coded on the description form.

Table 7.9 Synopsis of organic and mineral horizons consisting a humus form profile and usage of lowercase suffixes

Master horizons	Restricted lowercase suffixes	Subordinate horizons Unrestricted lowercase suffixes	
		Alone	**In combination**
L	Lo	Lλ, Lι	Lvι, Lvλ
	Lv		
F	Fq		Fqλ, Fqι, Fqβ, Fqθ,
	Fa	Fλ, Fι, Fβ	Faλ, Faι, Faβ,
	Faq		Faqλ, Faqι, Faqβ
H	Hr		Hrλ, Hrι, Hrβ,
	Hd	Hλ, Hι, Hβ,	Hdλ, Hdι, Hdβ
	Hda	Hθ, Hσ	Hdaλ, Hdaι, Hdaβ
O	Of	Oσ	Ofλ, Ofι, Ofβ,
	Om		Omλ, Omι, Omβ,
	Oh		Ohλ, Ohι, Ohβ
A	Ah		

2. Lab No.

The number assigned to a laboratory sample is recorded here.

3. Depth (cm)

In mineral soils, the top of the first mineral horizon is zero depth; in organic soils the top of the first horizon is zero depth. Thus, the depth of organic horizons in mineral soils should be measured upward from zero depth, and in organic soils, measured downward from zero depth. Mean depth in centimetres should be recorded.

4. Thickness (cm)

Thickness measurements are recorded in terms of minimum and maximum thickness of the horizon in centimetres. The proposed minimum thickness for describing and sampling humus form horizons is 0.5 cm.

5. Boundary

The *lower* boundary of each horizon should be described by its distinctness and form as follows:

Distinctness

Code	*Class*	*Abruptness of Vertical Changes*
A	Abrupt	<5 mm
C	Clear	5-10 mm
G	Gradual	11-20 mm
D	Diffuse	>20 mm

Form

Code	*Class*	*Variations in Boundary Plane*
S	Smooth	Nearly a plane
W	Wavy	Pockets wider than deep
I	Irregular	Pockets deeper than wide
B	Broken	Some parts are unconnected

6. MOISTURE STATUS

Some morphological properties of organic materials change with moisture content. Therefore, the moisture status of horizons at the time of description should be indicated according to the codes below:

Code	*Class*	*Description*
C	Desiccated	Extremely dry; organic tissues crack or snap when broken or crushed
D	Dry	Moisture is not apparent; material will not stain fingers when rubbed
M	Moist	Moisture is apparent; material will stain fingers when rubbed but no water is apparent when squeezed in the hand (generally below field capacity)
W	Wet	Water is observed if the material is squeezed or rubbed in the hand (generally above field capacity)
S	Saturated	Water is observed without squeezing or rubbing of the material

7. COLOUR

Colour is classified according to its hue, value, and chroma, using Munsell colour notations. The field colour is recorded along with the appropriate aspect code. Dry colour may also be recorded below field colour if required. Refer to Item 11 in Chapter Three for aspect codes.

8-10. FABRIC

Fabric is described in terms of the structure, consistence and character of the organic materials in the humus profile. The term "materials" refers here to plant residues and/or fine organic substances, with or without a mineral component.

8. Structure

Structure is classified according to the grade, size, and kind of the macromorphological aggregation of the material within a horizon or layer. Record structure grade code first, then size class code (if applicable), and lastly, kind code. Use a slash to separate codes. For example, a weak to moderate, fine to medium blocky structure is coded WM/FM/BK on the description form.

The grade is the degree of distinctive arrangement or aggregation of particles as defined below:

Code	*Grade Class*	*Description*
W	Weak	Disaggregated materials are dominant; <20% distinct aggregates
M	Moderate	Some disaggregated material is present; 20-60% distinct aggregates
S	Strong	Aggregated materials are dominant; most material conforms to the same arrangement; >60% distinct aggregates

Note that WM can be recorded for weak to moderate, and MS for moderate to strong grades.

The type of structure is divided into four classes. The first indicates that there is no structure (structureless or random); the second that the predominant structure is blocklike; the third that it is platelike (matted); and the fourth that it is columnlike. The types are further classified according to kinds of structure (Figure 7.1); refer to Table 7.10 for appropriate codes.

Blocklike structures are further classified into three size classes as follows:

Code	*Size Class*	*Dimension*
F	Fine	<5 mm
M	Medium	5-20 mm
C	Coarse	>20 mm

Note that FM can be recorded for fine to medium, and MC for medium to coarse sizes.

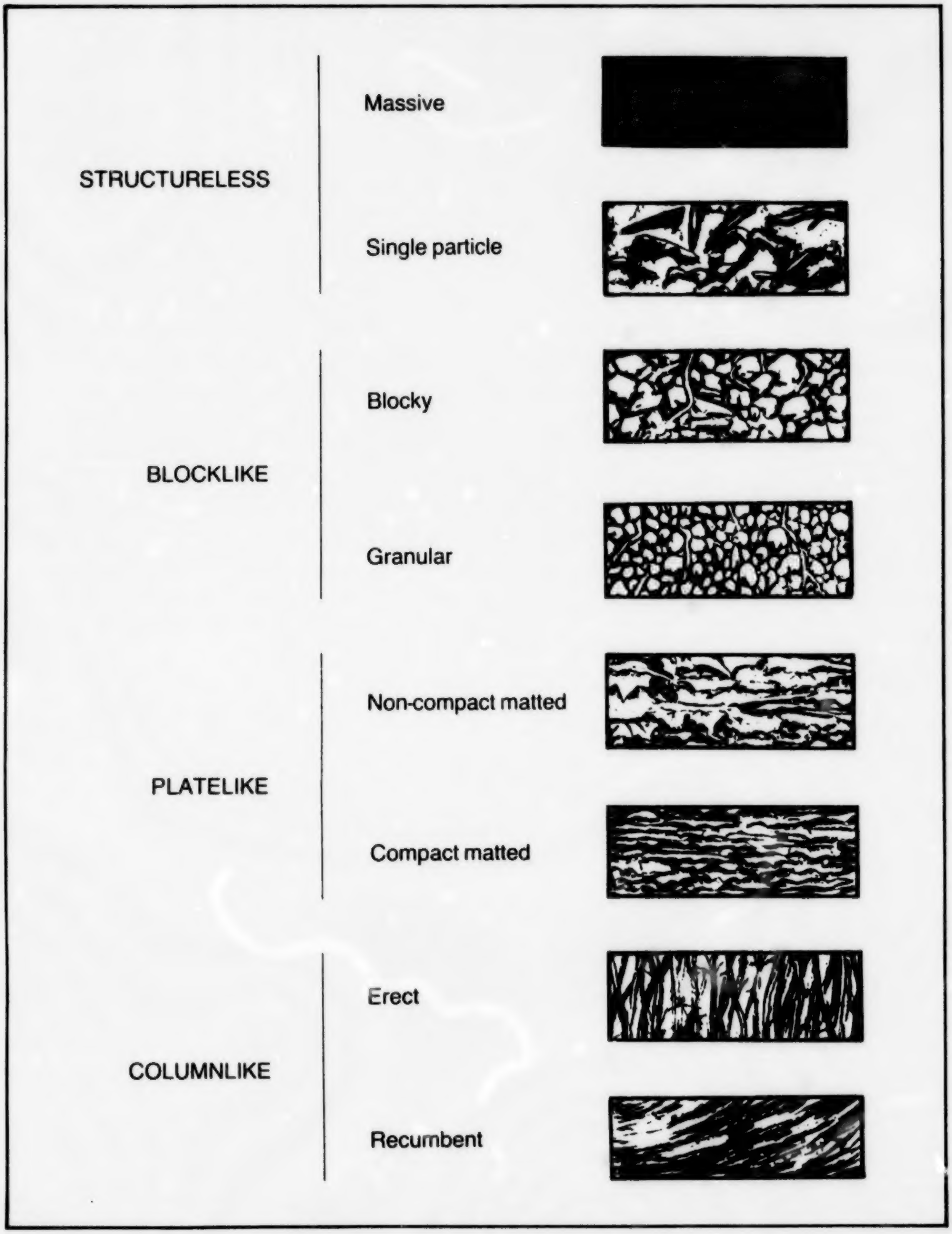
STRUCTURELESS
Massive
Single particle
BLOCKLIKE
Blocky
Granular
PLATELIKE
Non-compact matted
Compact matted
COLUMNLIKE
Erect
Recumbent

Figure 7.1 Schematic illustrations of classes of type and kind of structure

Table 7.10 Structure — classes of type and kind (after Klinka *et al.*, 1981)

Type		Kind		
Class	**Description**	**Class**	**Code**	**Description**
Structureless	No observable aggregation	Massive	MA	A coherent mass showing no evidence of aggregation
		Single particle	SP	An incoherent mass of individual particles (may be of various sizes) with no aggregation
Blocklike	Materials arranged around a point bounded by flat or rounded surfaces	Blocky	BK	Faces rectangular and flattened; vertices sharply angular
		Granular	GR	Spheroidal and characterized by rounded or sub-rounded vertices
Platelike	Materials arranged horizontally and parallel to each other, generally bounded by relatively flat horizontal surfaces	Non-compact matted	NM	Materials arranged along horizontal planes with no compaction
		Compact matted	CM	Materials arranged along horizontal planes with evident compaction
Columnlike	Materials arranged vertically	Erect	ER	Materials in vertical position
		Recumbent	RC	Materials in recumbent (reclining) position

9. Consistence

Consistence is a measure of the strength that holds the organic materials together, and is determined by the kind of deformation or rupture which occurs when pressure is applied and then released.

Code	*Class*	*Description*
LO	Loose	The material has no consistence
FR	Friable	The material crumbles easily under gentle pressure
FM	Firm	The material can be crushed under moderate pressure; resistance is noticeable
PL	Pliable	The material is soft and plastic
RE	Resilient	The material is springy or elastic; assumes its original shape after deformation forces are released
TE	Tenacious	The material is cohesive and not easily pulled apart. Degree of tenacity may be further described as weak, medium or strong.

10. Character

"Character" refers to the distinctive quality (tactility) of materials in the humus form profile. The descriptive terms are listed and defined below and may be used where applicable. Among them are terms that describe tactile qualities, particulate shapes, and other noteworthy qualities. Determining the character requires a qualitative examination of the fabric.

Code	*Class*	*Description*
MS	Mushy	Materials are wet or saturated, soft and spongy
MK	Mucky	Materials are usually wet, smooth, and sticky; they contain silt and clay sized mineral particles

GR	Greasy	Materials are smooth and slippery when moist and easily workable; fine mineral particles are usually absent
GT	Gritty	Refers to a rough tactility produced by mineral granules or coarse fragments
LF	Leafy	Refers to the tactility of materials produced by deciduous foliage showing a shingle-like layering (banded structure)
MO	Mossy	Refers to the tactility produced by bryophytes with more or less preserved vegetative structures
AC	Acerose	Refers to the tactility produced by particles having a tip, as the needles of conifers
FE	Felty	Refers to the tactility produced by abundant fungal mycelia
FI	Fibrous	Refers to tactility produced by an abundance of fibrous plant residues which do not break down upon rubbing (i.e. fine roots)
LG	Ligneous	Refers to the tactility produced by coniferous or deciduous wood fibres
CR	Crusty	Refers to a hard and brittle tactility of dry or desiccated materials

11. TEXTURE

Record the texture of any mineral horizon included in the humus form description (e.g., Ah horizon). Refer to Item 6 in Chapter Three for definition of texture.

12. MATERIAL COMPOSITION

Code as described in Item 24 in Chapter Three.

13. PYROPHOSPHATE INDEX

This colour test is outlined on page 29 of the "Canadian System of Soil Classification" (E.C.S.S., 1987). It is also briefly discussed in Item 24 of Chapter Three.

14. VON POST SCALE

Code as outlined in Item 24 of Chapter Three.

15. ROOTS

Describe roots by noting their abundance, size, and orientation. Distribution of roots (i.e., inped or exped), should only be described for mineral horizons. Since root distribution in humus forms differs substantially from that in mineral soils, the abundance and size classes, and the reference unit area have been modified from those in Chapter Three (Item 13), to provide a more precise description.

The reference unit area surface is 2.5 × 2.5 cm for fine and very fine roots and 25 × 25 cm for medium, coarse and very coarse roots. All living and dead roots are included due to the difficulties in distinguishing between them. Any roots obviously dead may be excluded, however. If possible, record the species or general types of plant (i.e., tree, shrub, etc.) from which the roots originate.

Root abundance is defined as:

Code	*Class*	*Number of Roots/Unit Area Surface*
X	None	0
V	Very few	<3
F	Few	3-10
C	Common	11-20
P	Plentiful	21-30
A	Abundant	>30

Root size is defined as:

Code	*Class*	*Size (dia. in mm)*	*Unit Area Surface*
V	Very fine	<1	2.5 × 2.5 cm
F	Fine	1-2	2.5 × 2.5 cm
M	Medium	3-10	25 × 25 cm
C	Coarse	11-25	25 × 25 cm
K	Very coarse	>25	25 × 25 cm

Root orientation is defined as:

Code	*Class*	*Description*
R	Random	Roots are oriented in all directions
O	Oblique	Roots are oriented along oblique planes
H	Horizontal	Roots are oriented along horizontal planes
V	Vertical	Roots are oriented along vertical planes

16. NON-CONFORMING MATERIALS

Materials that are dissimilar to most of the organic materials comprising the humus form are sometimes present. They seem to persist for longer periods of time as admixtures to the materials in the horizons, or they may form a distinct horizon or layer in the humus form profile.

The most common non-conforming materials are charcoal, decaying wood, and mineral coarse fragments. Their description includes the kind of material, their distribution, size, and abundance, but is recorded only when they form an admixture to prevailing materials in horizons.

No classification or codes exist for kinds of non-conforming materials, so simply record the full name of those encountered. Distribution and size classes for non-conforming materials are as follows:

Code	*Dist. Class*	*Description*
R	Random	Materials are distributed randomly; there is no recognizable, specific pattern of distribution
C	Clustered	Materials are distributed in clusters or groups
B	Banded	Materials are distributed in bands, sheets or layers

Code	*Size Class*	*Diameter (mm)*[1]	*Length (mm)*[1]
V	Very fine	<2	<5
F	Fine	2-10	5-20
M	Medium	11-50	21-100
C	Coarse	51-250	101-500
K	Very coarse	>250	>500

---

[1] Diameter measurements apply to rounded or subrounded particles; length measurements apply to particles with distinctly uneven axes.

Abundance refers to the volume occupied by non-conforming materials for each size class expressed as a percentage of the horizon volume. The codes are:

Code	*Abund. Class*	*Description*
N	None	None
F	Few	Occasional and scattered pieces; volume <5%
C	Common	Frequent occurrence; volume 5-20%
M	Many	Numerous, usually coarse pieces; volume >20%

Other relevant characteristics of non-conforming materials such as colour, degree of decomposition, and origin may be recorded.

17. SOIL BIOTA

Soil flora and fauna are important in humus formation and their description should not be overlooked. For the purpose of humus form description and taxonomy, the emphasis is on both a general qualitative and quantitative description.

Soil Flora

Soil flora includes bacteria, actinomycetes, algae and fungi. In most routine studies, the description of soil flora should be restricted to the fungi that inhabit the humus form profile.

Fungi are a large and varied group — rusts, moulds, yeasts, and mushrooms are a few of the major kinds. In most cases, their presence is indicted by masses of hyphae (threadlike filaments) called mycelia. A fungal mycelium constitutes the "vegetative" phase in the development of a fungus. While individual hyphae are generally too small to be seen, the mycelial mass is usually visible. Space provided on the description form under "kind" can also be used to note the colour of fungi present.

Describe fungal mycelia by noting their distribution and abundance as follows:

Code	*Dist. Class*	*Description*
R	Random	Fungal mycelia are randomly distributed, with no recognizable pattern of distribution
C	Clustered	Fungal mycelia are distributed in clusters or groups
B	Banded	Fungal mycelia are distributed in bands, sheets, or layers

Code	*Abund. Class*	*Description*
N	None	Fungal mycelia are not visible
F	Few	Fungal mycelia are occasionally present, but are scattered and not easily observed
C	Common	Fungal mycelia are commonly observed
A	Abundant	Fungal mycelia are observed continuously throughout the horizon, often "matting" materials together and creating a "felty" tactility

Soil Fauna

Soil fauna are those animals that "pass one or more active stages wholly or largely in the soil or surface litter, excluding those species which occur there only in passive stages, e.g., eggs, cysts or pupae "(Richards, 1974). The activity of fauna has a profound influence on humus formation. Through burrowing, comminution, and ingestion, soil fauna participate actively in decomposition, in synthesis of humus materials, and in the intermixing of humus and mineral soil.

The usual kinds of fauna present in humus forms are:

Code	*Fauna*	*Code*	*Fauna*
A	Mites *(Acarina)*	G	Woodlice *(Isopoda)*
B	Springtails *(Collembola)*	H	Centipedes and millipedes *(Myriapoda)*
C	Spiders *(Areneida)*	I	Termites *(Isoptera)*
D	Fly larvae *(Diptera)*	J	Earthworms *(Lumbricida)*
E	Beetles and larvae *(Coleoptera)*	K	Potworms *(Enchytraeida)*
F	Ants *(Hymenoptera)*	L	Nematodes *(Nematoda)*

Their general appearance is indicated in Figure 7.2. Either record the appropriate code(s) or describe the kind of fauna that is present.

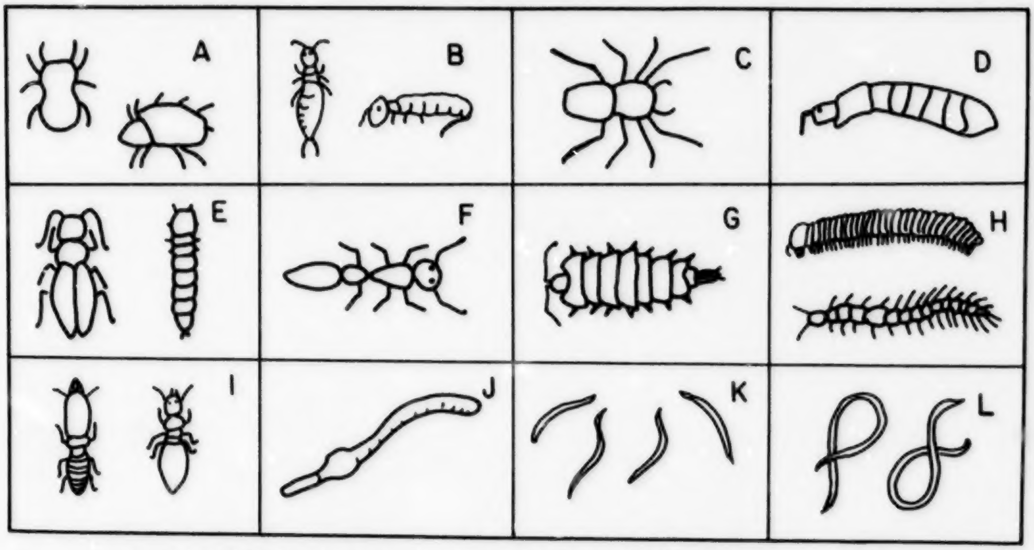

Figure 7.2 Major kinds of animals found in the soil (after Klinka *et al.*, 1981)

If possible, record the body size of soil fauna as follows:

Code	*Size Class*	*Description*
MA	Macrofauna	Animals with a body size greater than 10 mm (in the longest dimension); includes earthworms, vertebrates, molluscs and large arthropods
ME	Mesofauna	Animals with a body size in the range of 0.2-10 mm; includes some mites and springtails, potworms and most of the larger nematodes. The lower limit is about the limit of viewing with a 10X hand lens
MI	Microfauna	Organisms less than 0.2 mm in size; includes protozoa as well as many of the smaller mites and nematodes

Faunal populations (abundance) can be determined by either direct or indirect observation.

(a) direct observation — estimates of the relative abundance of soil fauna may be made providing that the observer can discriminate sufficiently in terms of the general kinds and size classes described previously. The classes of abundance are:

Code	*Abund. Class*	*Description*
N	None	No organisms observed
F	Few	Occasional, scattered organisms observed
C	Common	Organisms observed commonly
A	Abundant	Organisms observed frequently throughout the profile

(b) indirect observation — the presence of fauna is often indicated by their excrement ("droppings" or "casts"). Droppings constitute a significant portion of many organic horizons and, in some cases, can form the entire horizon.

The following general types of droppings can be recognized with a hand lens or binocular microscope (Hodgson, 1978).

Mite-type — usually formed by mites, Collembola, and Diptera larvae. Small (<0.1 mm in diameter), discrete, spherical or oval, humified, rust to dark brown, lacking mineral grains.

Enchytraeid-type — associated particularly with enchytraeid populations. Small (0.05 — 0.2 mm), discrete, sub-spherical, rugose, generally well humified and brown, but may contain varying amounts of mineral grains and clay.

Arthropod-type — formed by larger arthropods and small surface-feeding earthworms. Visible to the naked eye (1-3 mm long), discrete, well humified, dark brown, containing mineral grains but low in clay.

Wormcasts — largely caused by surface-casting earthworms. Well humified, generally brown or grayish-brown, containing mineral grains and clay, spongy or coarse rugose cast, granular structure (5-10 mm in diameter).

Droppings may be described by their abundance and distribution according to the following classes:

Code	*Dist. Class*	*Description*
R	Random	Droppings are randomly distributed, there is no recognizable pattern of distribution
C	Clustered	Droppings are distributed in clusters or groups
B	Banded	Droppings are distributed in bands, sheets, or layers

Code	*Abund. Class*	*Description*
N	None	No visible droppings
F	Few	Droppings occasionally observed but only scattered
C	Common	Droppings commonly observed
A	Abundant	Droppings frequently observed in relatively large numbers throughout the horizon

18. pH

Record the measured pH value, to one decimal place, followed by a slash, and then the method code. The method codes are:

Code	*Method*
1	Bromothymol blue
2	Cresol red
3	Hellige-Truog
4	Lamotte-Morgan
5	pH meter (1:1 H_2O)
6	pH meter (0.1 M $CaCl_2$)
7	Phenol red
8	Soiltex
9	Thymol blue
10	pHydrion

For example, 6.5/3 indicates a pH value of 6.5, determined by the Hellige-Truog method. pH is also discussed in Item 15, Chapter Three.

19. BULK DENSITY

Measured bulk density values, if determined, are recorded here. See Klinka *et al.* (1981) for specific procedures for bulk density sampling.

20. SCHEMATIC HUMUS FORM PROFILE

Space is provided to hand-sketch the described humus form profile.

NOTES

Record any additional comments here.

SOIL TEMPERATURE

Record soil temperatures (°C) at one or more of the appropriate depths shown (i.e., 0, 10, 50 and 100 cm depths).

METHODS OF SAMPLING AND ANALYSIS

The method employed for humus form sampling depends on the objectives of the study and on the analyses to be undertaken. Information concerning sample collection, preparation, and recommended chemical analyses is given in Klinka *et al.* (1981).

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